A380
TECHNICAL TRAINING MANUAL
MAINTENANCE COURSE - T1 + T2 (EA GP 7200)
LEVEL II&III - ATA 70 Power Plant (EA)

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LEVEL II&III - ATA 70 POWER PLANT (EA)

Nacelle & Engine

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NACELLE DESCRIPTION (EA) (3)

General Overview

Purpose

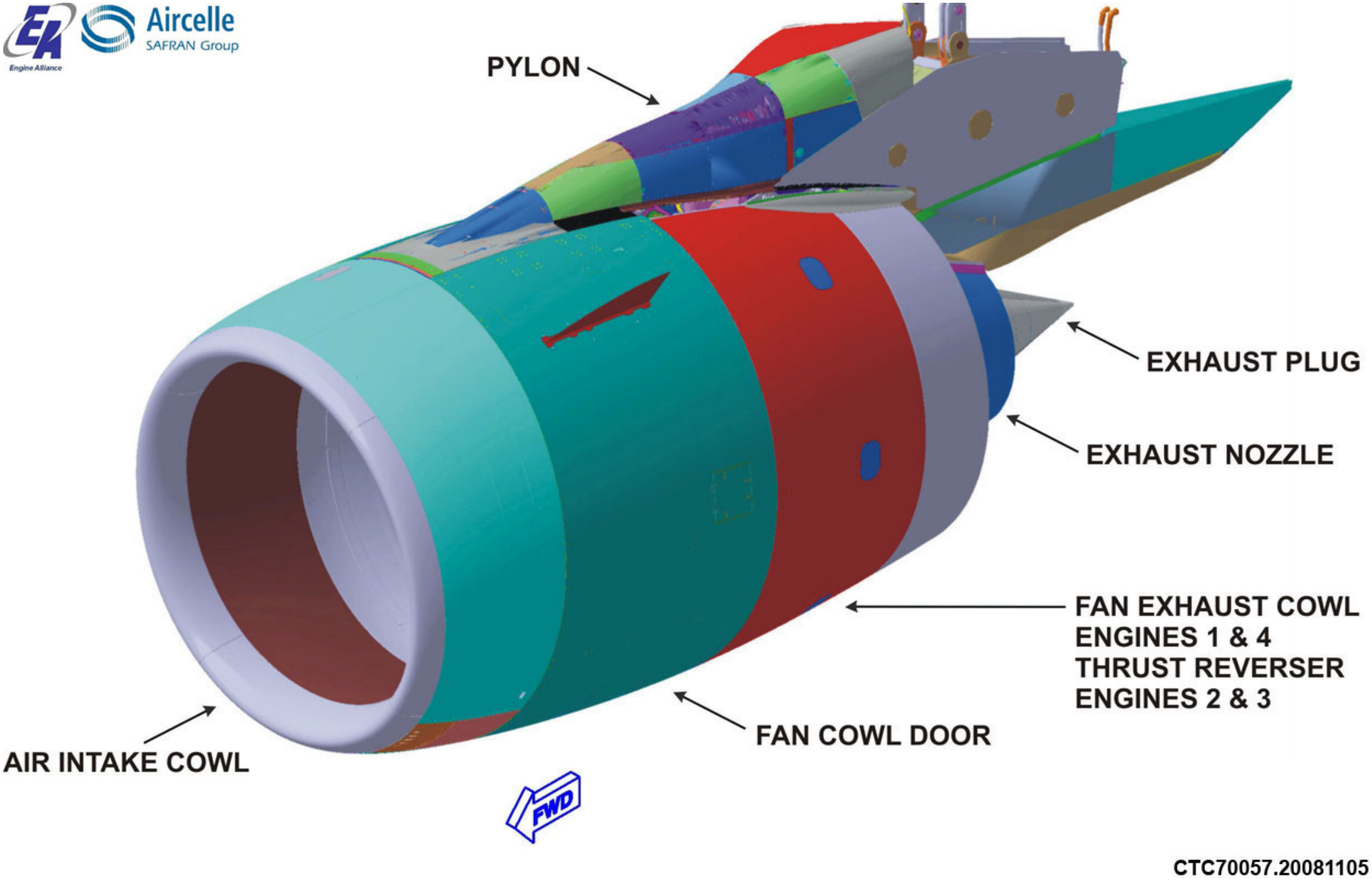
The nacelle is the aerodynamic structure around the engine.

Components

Air intake cowl,
Fan cowl doors,
Fan exhaust cowls for outboard engines,
Thrust reverser cowl doors for inboard engines,
Electronic Thrust Reverser Actuation System (ETRAS),
Exhaust nozzle and plugs (rear and forward).

Description and Operation

The primary functions of the nacelle:
- Ensure smooth airflow both around and into the engine,
- Protect the engine and the engine accessories,
- Provide engine noise attenuation,
- Permit access to the engine and its components for servicing and maintenance,
- Provide ventilation of the engine fan and core zones,
- Participate in engine load distribution (load sharing),
- Reverse the engine fan airflow after landing to decelerate the aircraft.


PYLON
EXHAUST PLUG
EXHAUST NOZZLE
FAN EXHAUST COWL
ENGINES 1 & 4
THRUST REVERSER
ENGINES 2 & 3
FAN COWL DOOR
AIR INTAKE COWL
FWD
CTC70057.20081105

GENERAL OVERVIEW - PURPOSE ... DESCRIPTION AND OPERATION

NACELLE DESCRIPTION (EA) (3)

Air Intake Cowl - General

Purpose

The function of the air intake cowl is to provide:
- Smooth and sufficient air flow to the engine,
- Smooth air flow over the nacelle outer surfaces.

Components

Structures:
- Lip,
- Anti-ice and T12 probe access panels,
- Outer barrel,
- Inner barrel,
- Forward and Aft Bulkhead,
- Aft bulkhead lambda stiffener.

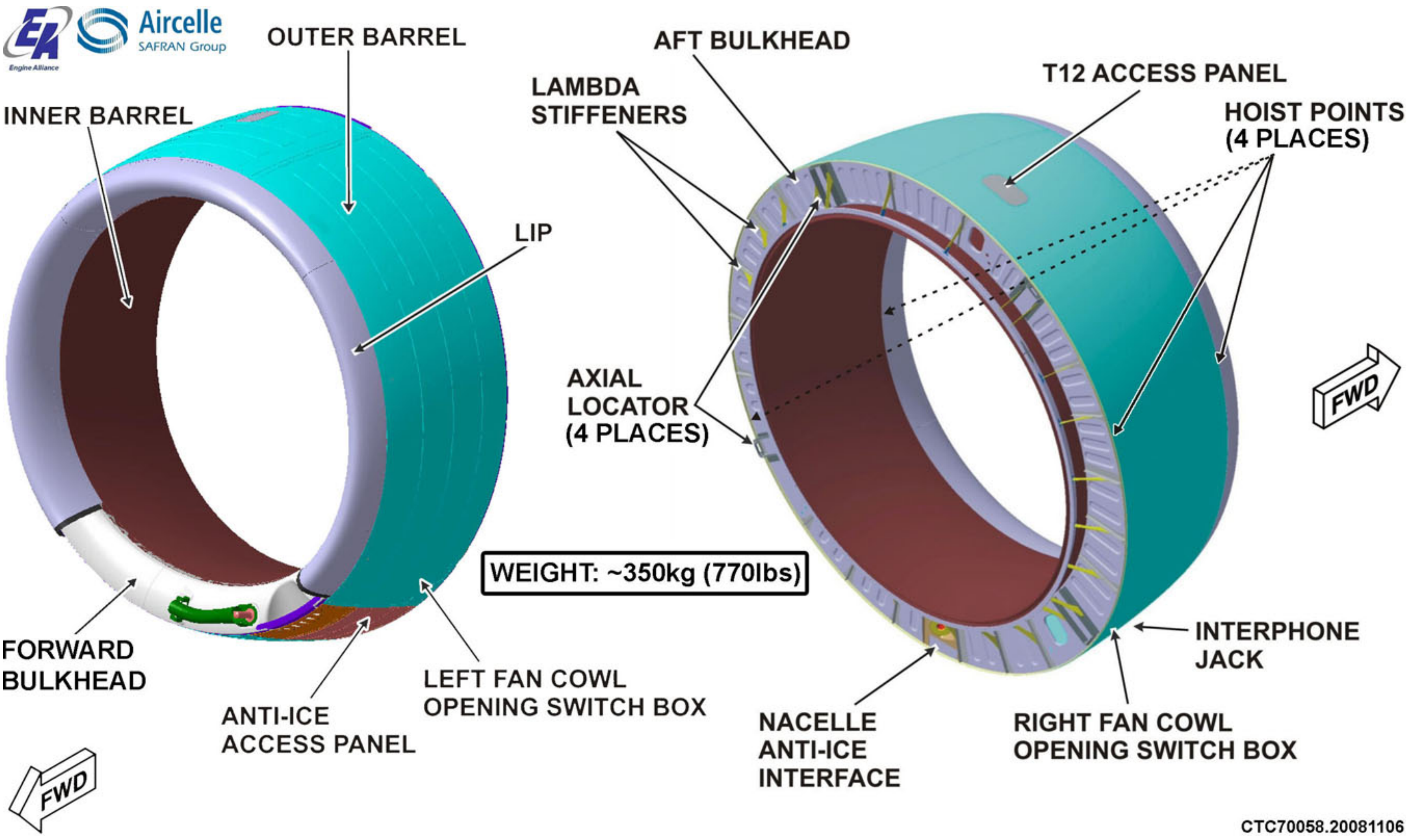
Systems:
- Anti-ice ducting
- Interphone jack (only on right side),
- T12 probe and harness,
- Fan cowl opening switch boxes (both sides),
- Hoisting points (4 places),
- Axial locator receptacles (4 places).

Description

The air intake cowl controls the airflow into the engine fan.
The air intake cowl provides engine noise attenuation by using acoustic materials.
The air intake cowl is an interchangeable component attached to the engine fan case.
The air intake cowl contains the anti-ice system.
The air intake cowl incorporates the interphone jack and the engine T12 probe.
Panels are provided on the air intake cowl to give quick access to the internal components.
Weight: approximately 770 lb (350 Kg).

LRUs

Air intake cowl,
T12 probe, T12 harness, T12 ramp,
Interphone jack,
Fan Cowl Opening System (COS) harness,
Anti-ice tube,
Anti-ice exhaust panel,
T12 access panels.


Engine Alliance
Aircelle
SAFRAN Group
OUTER BARREL
INNER BARREL
LIP
AFT BULKHEAD
LAMBDA STIFFENERS
T12 ACCESS PANEL
HOIST POINTS (4 PLACES)
AXIAL LOCATOR (4 PLACES)
FWD
WEIGHT: ~350kg (770lbs)
FORWARD BULKHEAD
ANTI-ICE ACCESS PANEL
LEFT FAN COWL OPENING SWITCH BOX
NACELLE ANTI-ICE INTERFACE
RIGHT FAN COWL OPENING SWITCH BOX
INTERPHONE JACK
FWD
CTC70058.20081106

AIR INTAKE COWL - GENERAL - PURPOSE ... LRUS

NACELLE DESCRIPTION (EA) (3)

Anti Ice Duct

Purpose

The anti ice duct delivers hot air from the engine to the air intake cowl lip.

Location

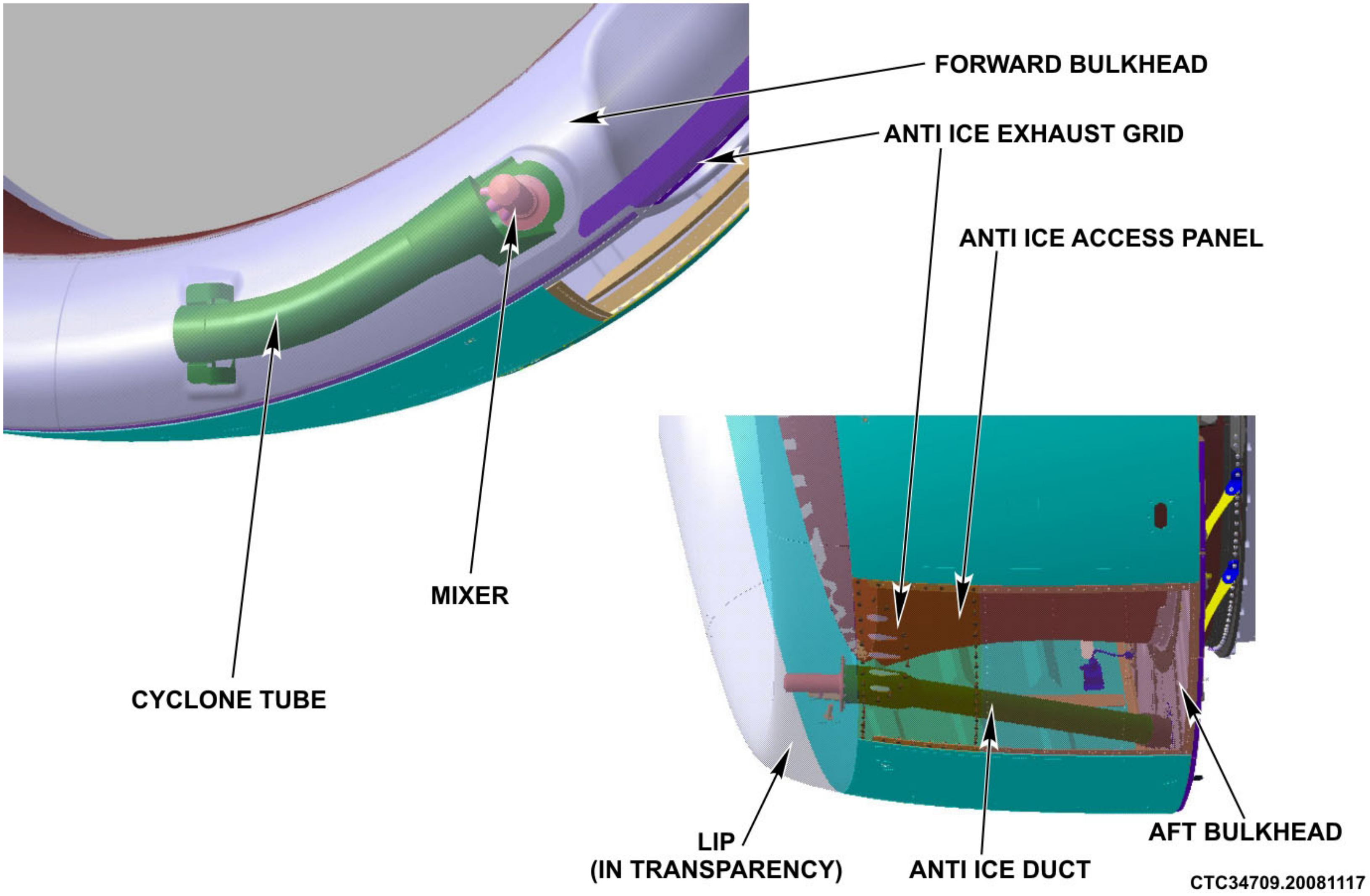
Inside the air intake cowl at 6 o'clock.
Access through the anti ice access panel.

Components

Anti Ice Duct,
Cyclone Tube (inside the lip),
Anti Ice access panel with exhaust grid.
Mixer (inside the lip)

Description

The hot air flows from the duct to the lip through a cyclone tube and a mixer.
The hot air is vented overboard through the access panel exhaust grid.


FORWARD BULKHEAD
ANTI ICE EXHAUST GRID
ANTI ICE ACCESS PANEL
MIXER
CYCLONE TUBE
LIP
(IN TRANSPARENCY)
ANTI ICE DUCT
AFT BULKHEAD
CTC34709.20081117

ANTI ICE DUCT - PURPOSE ... DESCRIPTION

NACELLE DESCRIPTION (EA) (3)

Air Intake Cowl - T12 Probe

Purpose

The T12 probe is a sensor that provides the temperature of the air that enters in the air intake cowl.

Location

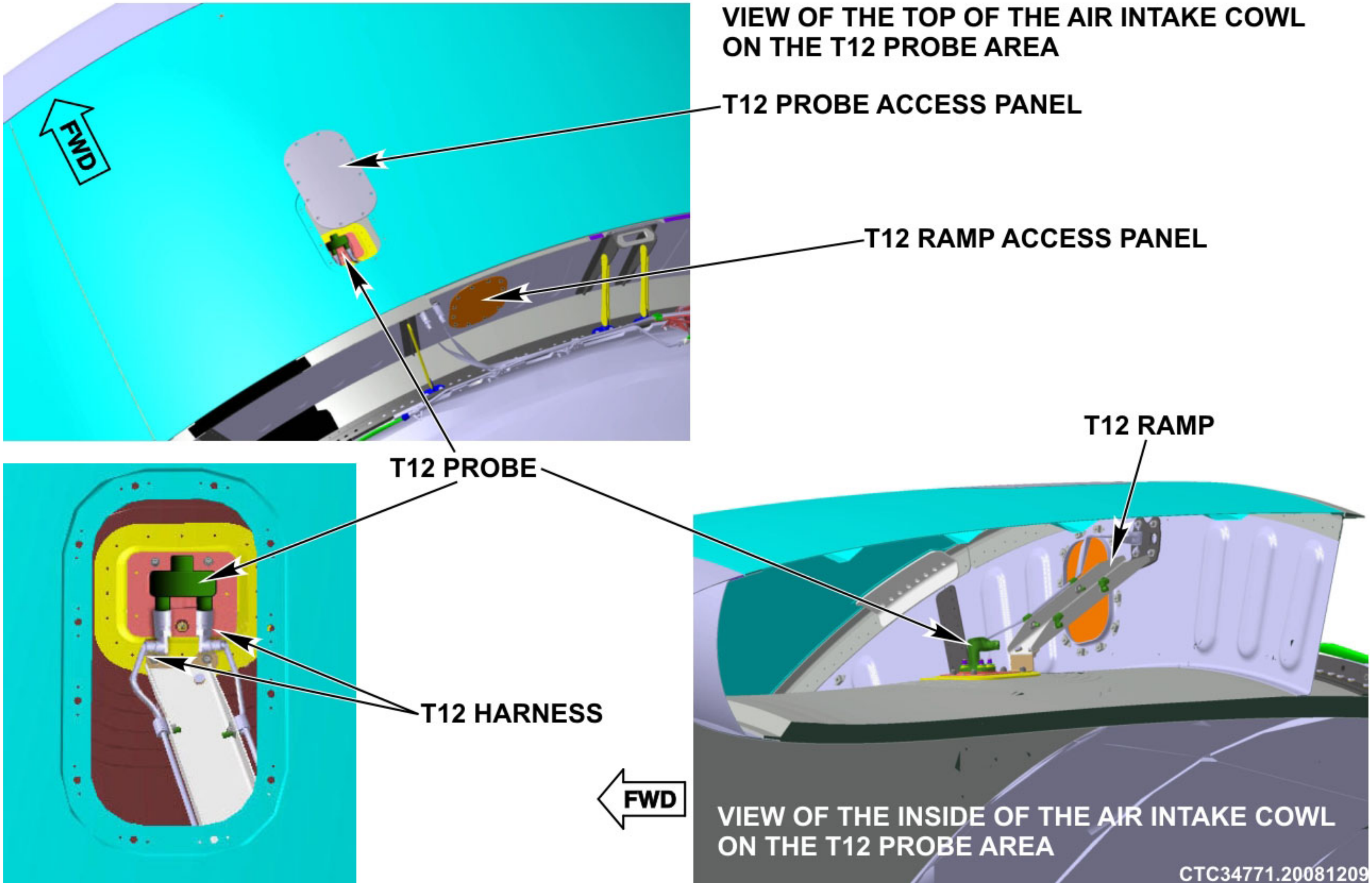
Inner barrel of the air intake cowl at 1 o'clock.

Components

T12 probe,
T12 harness,
T12 ramp.

Description

This probe is an engine component
The information of the probe is sent to the EEC.
The T12 harness is mounted on the T12 ramp.
A panel on the outer barrel of the air intake cowl at 1 o'clock gives access to the T12 probe.
Another panel on the aft bulkhead of the air intake cowl at 1o'clock allows the inspection and the removal/installation of the T12 harness and ramp


VIEW OF THE TOP OF THE AIR INTAKE COWL ON THE T12 PROBE AREA
FWD
T12 PROBE ACCESS PANEL
T12 RAMP ACCESS PANEL
T12 RAMP
T12 PROBE
T12 HARNESS
FWD
VIEW OF THE INSIDE OF THE AIR INTAKE COWL ON THE T12 PROBE AREA
CTC34771.20081209

AIR INTAKE COWL - T12 PROBE - PURPOSE ... DESCRIPTION

NACELLE DESCRIPTION (EA) (3)

Fan Cowl Doors - General

Purpose

The Fan Cowl Doors (FCD) protect the fan case.

Location

The installation of the fan cowl doors is around the engine fan case between the air intake cowl and the thrust reverser cowl doors.

Components

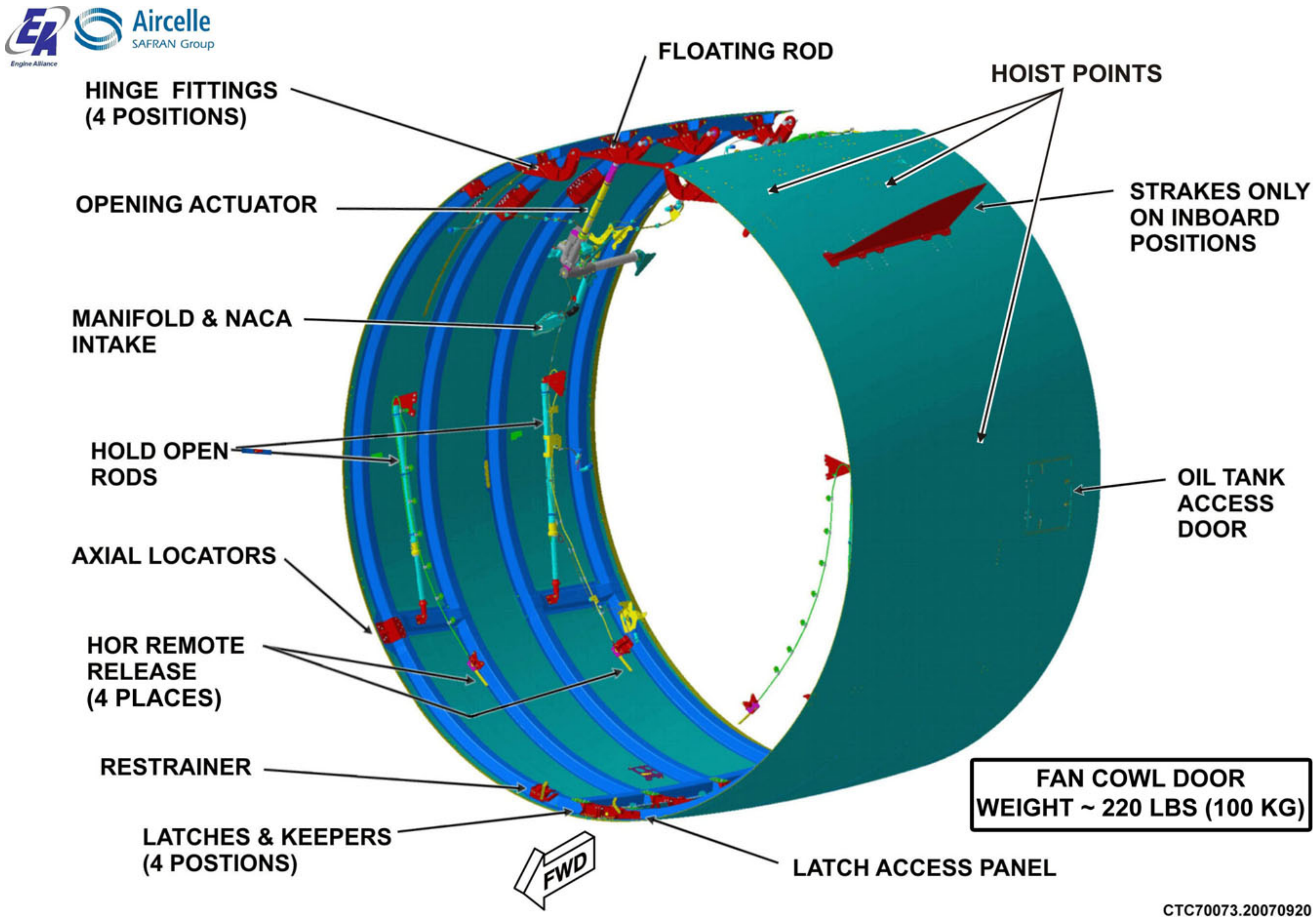
Hinge fittings
Floating rod
Primary Cowl Opening System Power Unit (PCPU) (on engine)
Opening actuator
The Hold Open Rods (HOR)
HOR remote release mechanisms (on engine)
Latch access panel
Latches (LHS) and keepers (RHS)
Axial locators and guide ramp
Hoisting points (3 places)
Strake
Restrainers
Oil tank access door
Manifold and NACA intake (EEC cooling)

Description

The fan cowl assembly has two semicircular composite panels, the left fan cowl door and the right fan cowl door
The FCD are interchangeable side by side, only on the same wing, because the strakes are installed on the inboard FCD. If a FCD has to be installed on the other wing, the strake must be swapped.
Each FCD is hinged to the aircraft pylon with four hinges. One hinge is connected to a floating beam which connects the two FCD together.
The FCD are latches together along the bottom split line with four tension hook latches.
Each FCD opens electrically with an opening actuator, power is supplied by the PCPU, and is maintained in the open position by two hold open rods.
Two axial locators, installed at the forward end of each cowl door, engage in receptacles on the air intake cowl. They align the fan cowl door in the closed position and prevent axial movement.
A guide ramp, located in the bottom aft edge, guides the fan cowl door during closure operation along the thrust reverser/fan exhaust cowl interface.
Restrainer, located on the lower forward edge of the fan cowl door, prevents deflection and scooping of the forward edge.
Weight: ~100kg (220 lbs) per cowl door.

LRUs

Fan cowl doors,
Latches and keepers,
Opening actuator,
Hold open rod and its remote release mechanism,
Latch access panel,
Oil tank access door,
Floating rod.


Engine Alliance
Aircelle
SAFRAN Group
FLOATING ROD
HOIST POINTS
HINGE FITTINGS
(4 POSITIONS)
OPENING ACTUATOR
STRAKES ONLY
ON INBOARD
POSITIONS
MANIFOLD & NACA
INTAKE
HOLD OPEN
RODS
OIL TANK
ACCESS
DOOR
AXIAL LOCATORS
HOR REMOTE
RELEASE
(4 PLACES)
RESTRAINER
FAN COWL DOOR
WEIGHT ~ 220 LBS (100 KG)
LATCHES & KEEPERS
(4 POSTIONS)
FWD
LATCH ACCESS PANEL
CTC70073.20070920

FAN COWL DOORS - GENERAL - PURPOSE ... LRUS

NACELLE DESCRIPTION (EA) (3)

Fan Cowl Doors - Hold Open Rods

Purpose

Each Fan Cowl door opens and is maintained in the open position by two Hold Open Rods (HOR) for ground maintenance tasks

Location

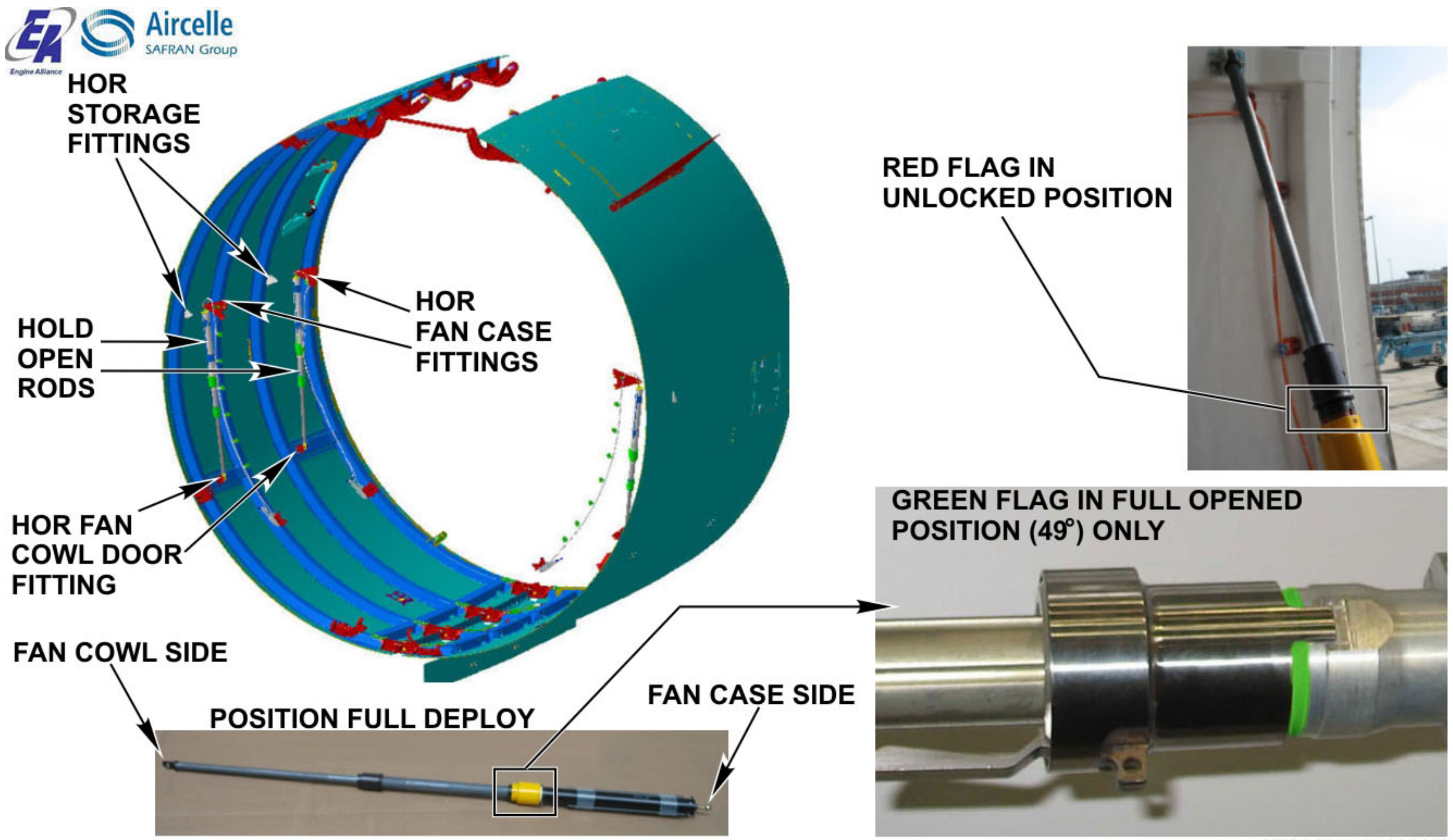
The ends of the HOR are attached to a fitting on the fan cow door and to a bracket on the engine fan case

Description

The HOR lock automatically in the open position of the fan cowls at 41° and 49°.
The HOR have color flags that provide visual indication to maintenance about the lock or unlock conditions of the rods. Red color unlocked, green color locked.
When FCD are removed from the engine, the HOR shall be engage on the FCD's storage fittings.

Maintenance Recommendations:

Intermediate position (41°) is considered only as a temporary position necessary for fan cowl door manual opening, it is not a secure position for maintenance activities.


HOR STORAGE FITTINGS
HOLD OPEN RODS
HOR FAN CASE FITTINGS
HOR FAN COWL DOOR FITTING
FAN COWL SIDE
POSITION FULL DEPLOY
FAN CASE SIDE
RED FLAG IN UNLOCKED POSITION
GREEN FLAG IN FULL OPENED POSITION (49°) ONLY

CTC34715.20081119

FAN COWL DOOR OPENING ANGLE : α	0°	$0^\circ < \alpha < 41^\circ$	41° INTERMEDIATE POSITION LOCKED	$41^\circ < \alpha < 49^\circ$	49° FULL OPENED POSITION LOCKED
HOR FLAG COLOR	RED	RED	NO COLOR	NO COLOR	GREEN

FAN COWL DOORS - HOLD OPEN RODS - PURPOSE ... MAINTENANCE RECOMMENDATIONS:

NACELLE DESCRIPTION (EA) (3)

Hold Open Rods - Remote Release Levers

Purpose

To unlock the hold open rods for closing or changing opening positions of the fan cowl doors.

Location

The hold open rods remote release levers are attached to the fan case at 5:30 and 6:30 position.

Description

The remote release mechanism consists of a handle, attached to the fan case, and a cable that connects the handle to the hold open rod locking feature.

Fan Cowl Door HOR Remote Release System Inhibition Plates

Purpose

The inhibition plates prevent the operator from unlocking the HOR with the remote release system, in case of actuator missing

Location

Normal operation: The inhibition plates are installed on the Fan cowl door opening actuator storage bracket.
Opening actuator missing: The inhibition plates are installed in front of the HOR remote release handles.

Description

If the Fan cowl door opening actuator is removed, it is necessary to installed inhibition plates in front of the HOR remote release handles to prevent an operator from unlocking the HOR.
There are two inhibition plates per door and they can't be miss installed due to their specific shape
The inhibition plates are marked with warnings on both sides.

Primary Cowl Opening System Power Unit

Purpose

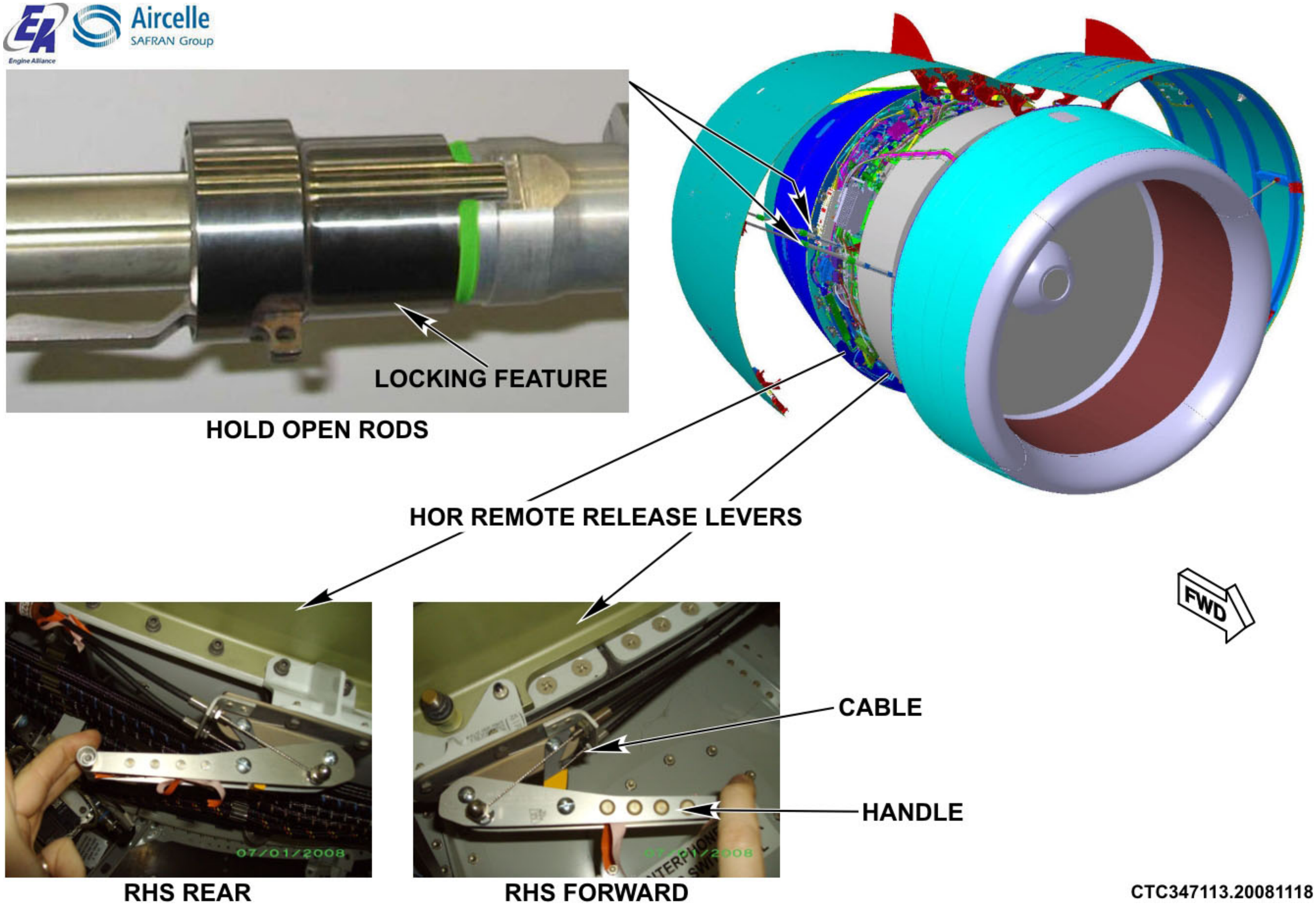
Convert the aircraft AC electrical power to DC for the fan cowl and reverser cowl door opening actuators.

Location

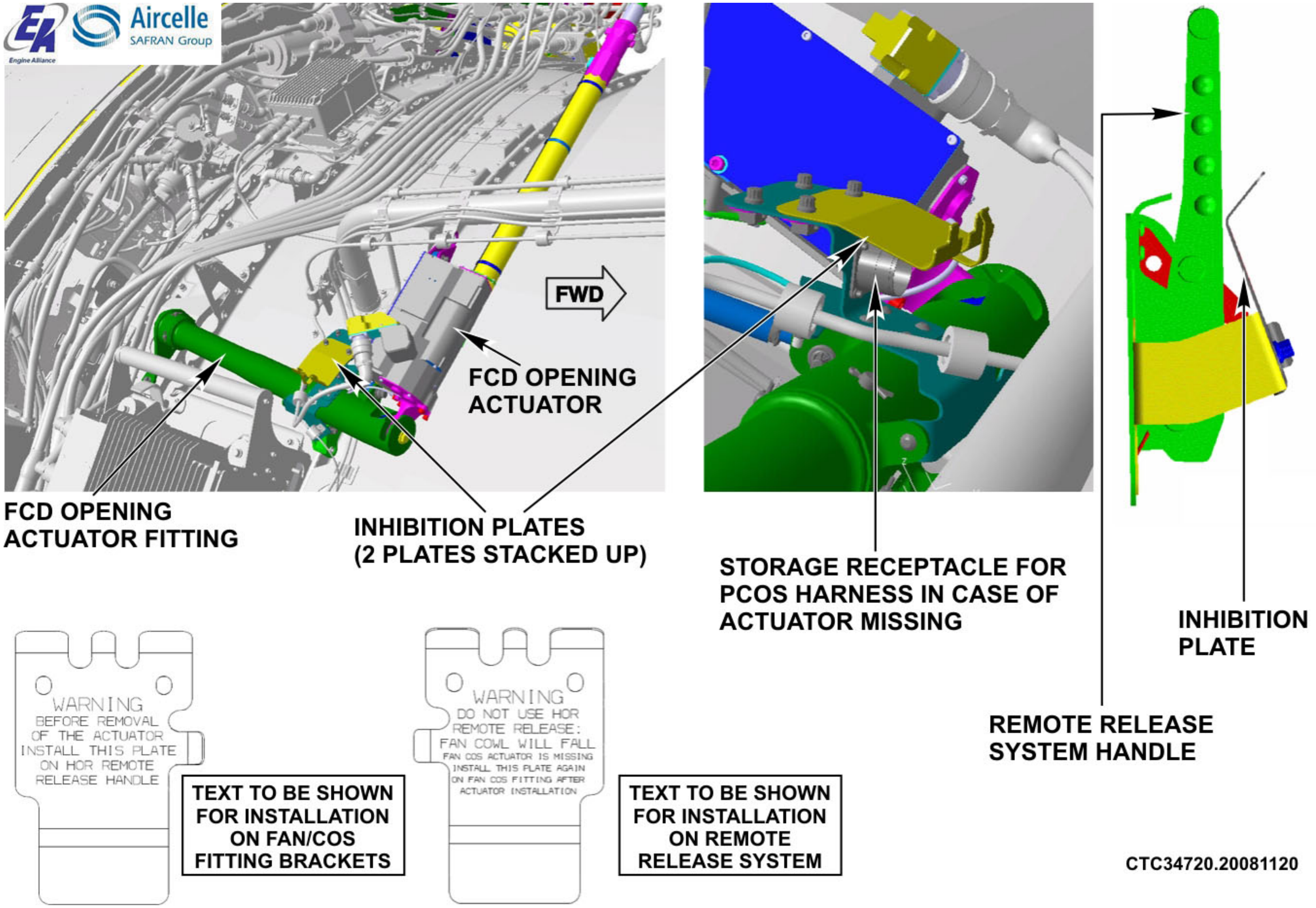
The Primary Cowl Opening System Power Unit (PCPU) is installed on the top of the fan case.

Description

The aircraft supplies 115VAC to the primary COS power unit
The primary COS power unit supplies the Fan COS actuators with 28VDC
The primary COS power unit supplies the TR COS actuators with 270VDC


LOCKING FEATURE
HOLD OPEN RODS
HOR REMOTE RELEASE LEVERS
CABLE
HANDLE
FWD
07/01/2008
07/01/2008
RHS REAR
RHS FORWARD
CTC347113.20081118

HOLD OPEN RODS - REMOTE RELEASE LEVERS ... PRIMARY COWL OPENING SYSTEM POWER UNIT


EA Engine Alliance
Aircelle SAFRAN Group
FWD
WARNING
BEFORE REMOVAL
OF THE ACTUATOR
INSTALL THIS PLATE
ON HOR REMOTE
RELEASE HANDLE
WARNING
DO NOT USE HOR
REMOTE RELEASE:
FAN COWL WILL FALL
FAN COS ACTUATOR IS MISSING
INSTALL THIS PLATE AGAIN
ON FAN COS FITTING AFTER
ACTUATOR INSTALLATION

FCD OPENING ACTUATOR

FCD OPENING ACTUATOR FITTING

INHIBITION PLATES (2 PLATES STACKED UP)

STORAGE RECEPTACLE FOR PCOS HARNESS IN CASE OF ACTUATOR MISSING

INHIBITION PLATE

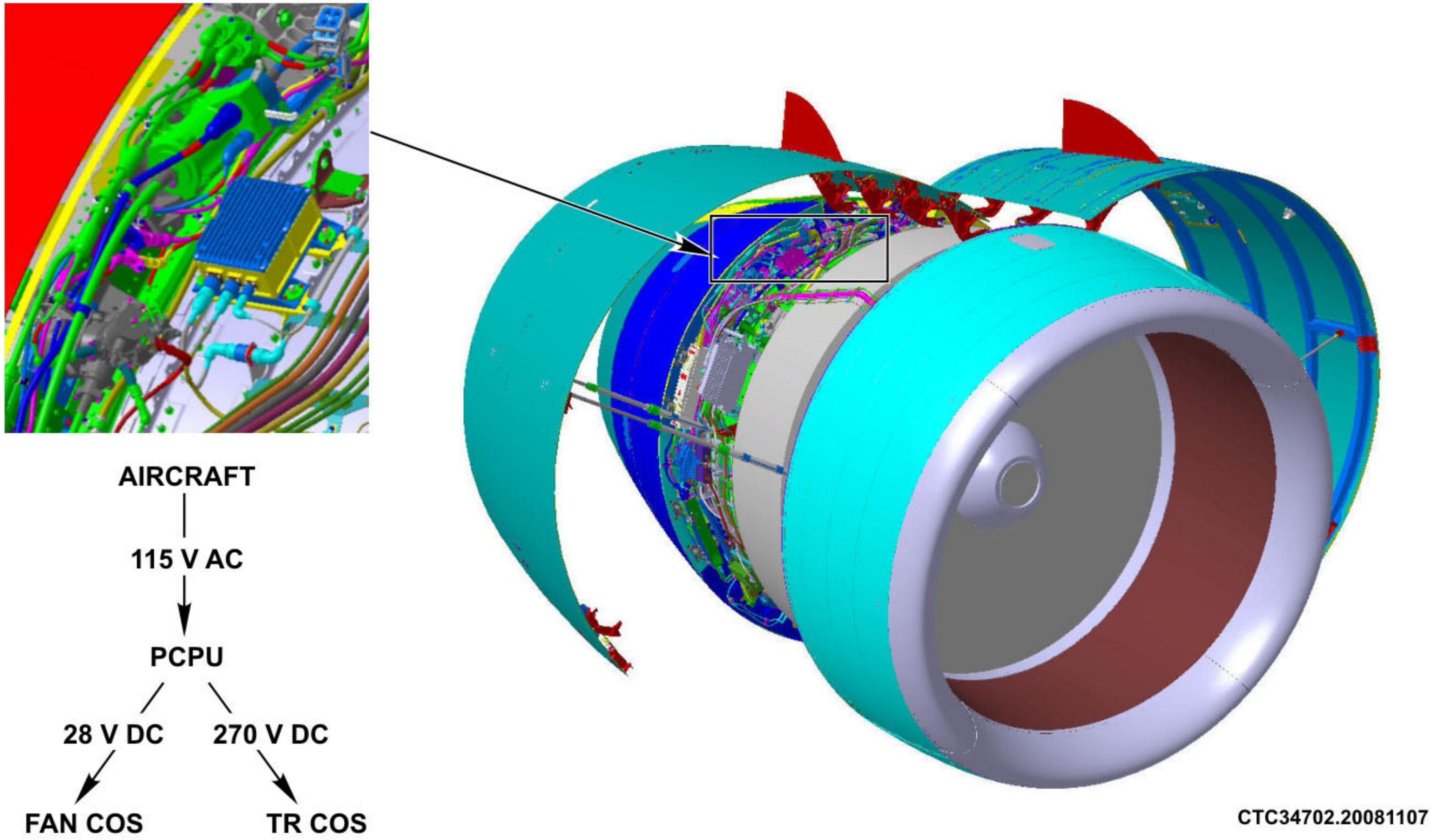
REMOTE RELEASE SYSTEM HANDLE

TEXT TO BE SHOWN FOR INSTALLATION ON FAN/COS FITTING BRACKETS

TEXT TO BE SHOWN FOR INSTALLATION ON REMOTE RELEASE SYSTEM

CTC34720.20081120

HOLD OPEN RODS - REMOTE RELEASE LEVERS ... PRIMARY COWL OPENING SYSTEM POWER UNIT



AIRCRAFT

115 V AC

PCPU

28 V DC

270 V DC

FAN COS

TR COS

CTC34702.20081107

HOLD OPEN RODS - REMOTE RELEASE LEVERS ... PRIMARY COWL OPENING SYSTEM POWER UNIT

NACELLE DESCRIPTION (EA) (3)

Fan Cowl Door Opening/Closing

Purpose

The Fan Cowl Door (FCD) needs to be open to get access to the fan compartment for maintenance or servicing, or to open the thrust reverser/fan exhaust cowl doors.

Opening the Fan Cowl Door

You must have electric power before you use the actuator,
Make sure the area around the engine is clear,
Open the Latches Access Panel and the four FCD latches,
Latch opening sequence: L4 - L1 - L3 - L2.

WARNING: CAUTION: Intermediate position (41°) is consider only a temporary position necessary for fan cowl door manual opening, and not as secured position for maintenance activities

WARNING: Do not pass under the FCD before verifying that both hold open rods are locked.
Press on the UP button of the air intake cowl switch box to open the door until the hold open rod locks engage at the 49° position.

NOTE: Note: At the end of the opening (49° position), the actuator is on free wheel.
Push the DOWN button momentarily to put the fan cowl door weight on the hold open rods.

Training Information Point

In case of actuator jamming, it is possible to disconnect the actuator from the fan cowl door (4 screws to remove from the external side).

If the actuator is not present, two people are necessary to open/close the fan cowl door. A third person operates the hold open rod.
There are flag indicators to show the hold open rod state:
- Red indicator: Unlocked between 0° and 41° positions,
- No color: Locked at 41° position and unlocked between 41° and 49° positions.
- Green indicator: Locked at 49° position

WARNING: Do not operate the hold open rod remote release handles if the fan cowl opening system actuator is removed.

Two remote release handles shall be operated to unlock the two fan cowl door hold open rods.
The hold open rod flag indicators must be red during the closing sequence.

Closing the Fan Cowl Doors

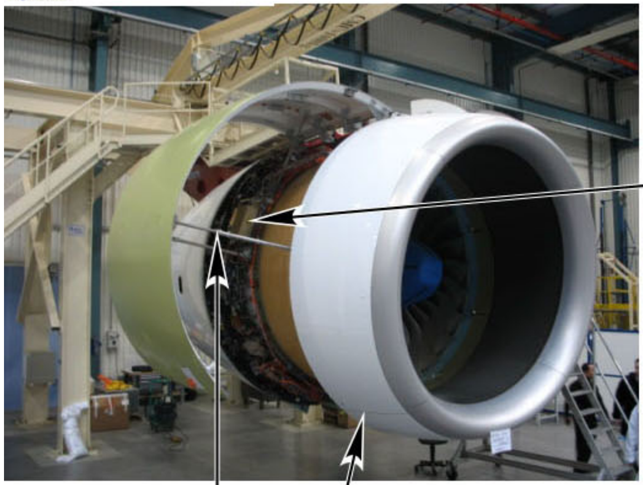
Press on the UP button of the air intake cowl switch box to release loads from the hold open rods,
Unlock the hold open rods: Activate the remote release,
Press on the DOWN button to fully close the doors,
Latch the fan cowl doors (double triggers),
Latches closing sequence: L2 - L3 - L1 - L4,
Close the zebra painted latch access panel.

NOTE: Note: The latch access panel can not be closed if the fan cowl door latches are not properly latched.

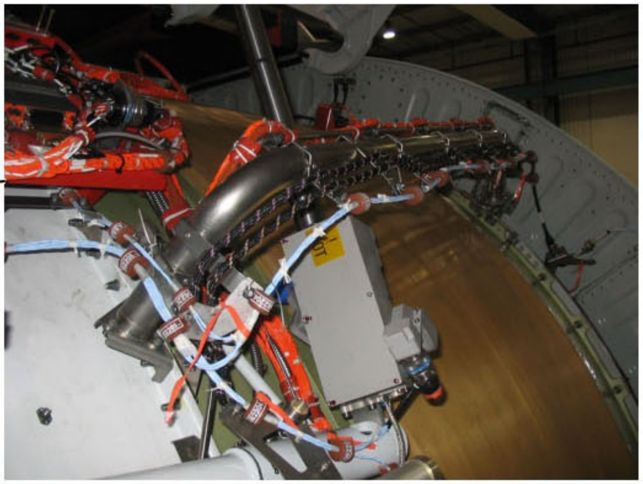
Training Information Point

The fan cowl door opens in approximately 20 seconds.
When you open both fan cowl doors at the same time, it takes approximately 50 seconds.
You can close only one fan cowl door at a time.
The fan cowl door closes in approximately 25 seconds.

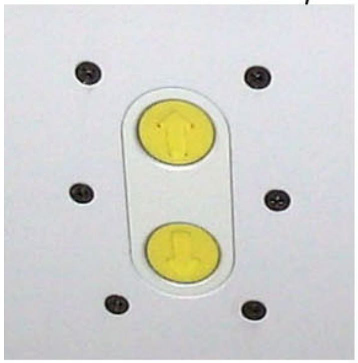
Aircelle
SAFRAN Group



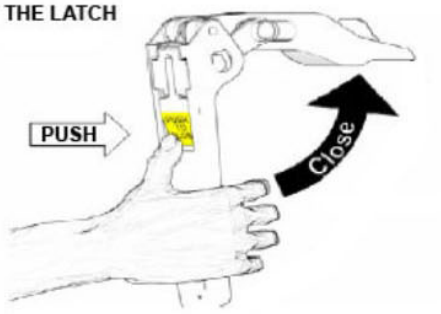
HOLD OPEN ROD FLAG INDICATOR



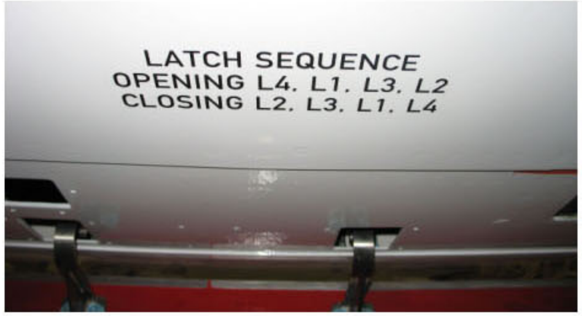
ACTUATOR



SWITCH BOX


THE LATCH
PUSH
Close

LATCH CLOSING


LATCH SEQUENCE
OPENING L4. L1. L3. L2
CLOSING L2. L3. L1. L4

LATCH SEQUENCE

CTC70063.20081121

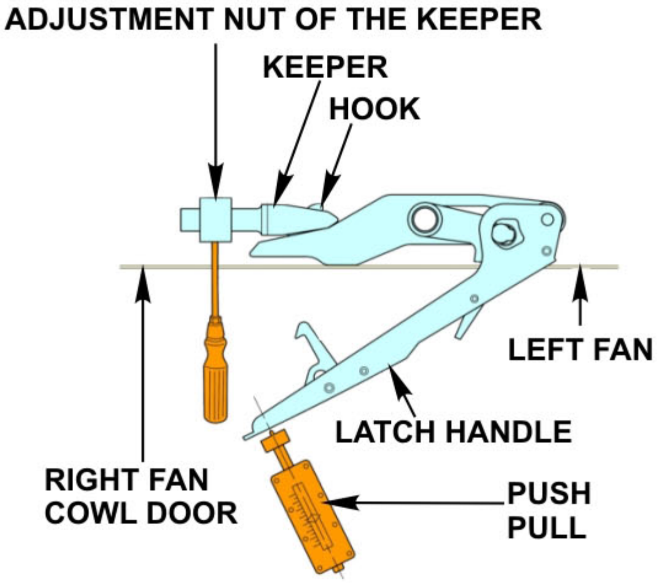
FAN COWL DOOR OPENING/CLOSING - PURPOSE ... TRAINING INFORMATION POINT

NACELLE DESCRIPTION (EA) (3)

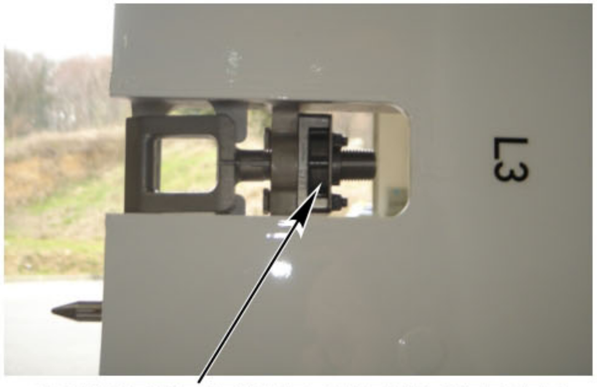
Fan Cowl Doors Latches Rigging

Fan Cowl Doors Latches Rigging

You must check the latches in the sequence L2, L3, L1 and L4,
Check that all the latches are fully closed,
Open the latch to be checked,
Measure the applied force to close the latch with a push gage,
The force needed to close the latches must be between 14.7 and 17.8 daN (33 and 40 lbf), check AMM
If the force is not correct, adjust the latch tension as follows:
- Open the latch,
- Push the keeper to disengage the tension nut from the locking pin,
- Turn the tension nut clockwise to increase the tension and counter-clockwise to decrease the tension,
- Measure the applied force to close the latch with a push gage,
- Repeat this procedure to get the required tension on the latch handle.

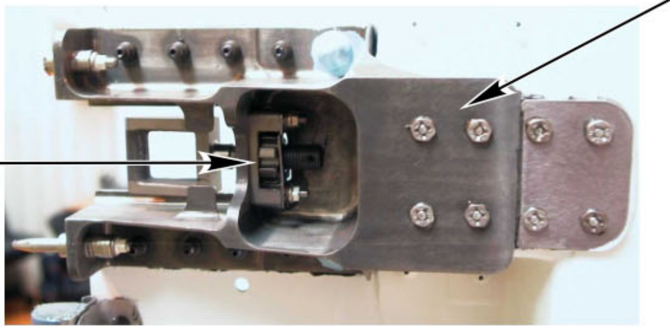

ADJUSTMENT NUT OF THE KEEPER
KEEPER
HOOK
LEFT FAN
LATCH HANDLE
RIGHT FAN COWL DOOR
PUSH
PULL

LATCHES CLOSING FORCE:
BETWEEN 14,7 DAN AND 17,8 DAN (33 LBF AND 40 LBF)
CHECK AMM


L3
ADJUSTMENT NUT OF THE KEEPER

VIEW OF SECTION OF LATCH AND KEEPER

KEEPER ASSEMBLY


ADJUSTMENT NUT

CTC34768.20081205

FAN COWL DOORS LATCHES RIGGING - FAN COWL DOORS LATCHES RIGGING

NACELLE DESCRIPTION (EA) (3)

Thrust Reverser Cowl Doors - General

Purpose

The main function of the thrust reverser is to decelerate the aircraft at landing
The thrust reverser assembly encloses the engine core with an aerodynamic flow path, and provides a fan exhaust duct and nozzle exit.

Location

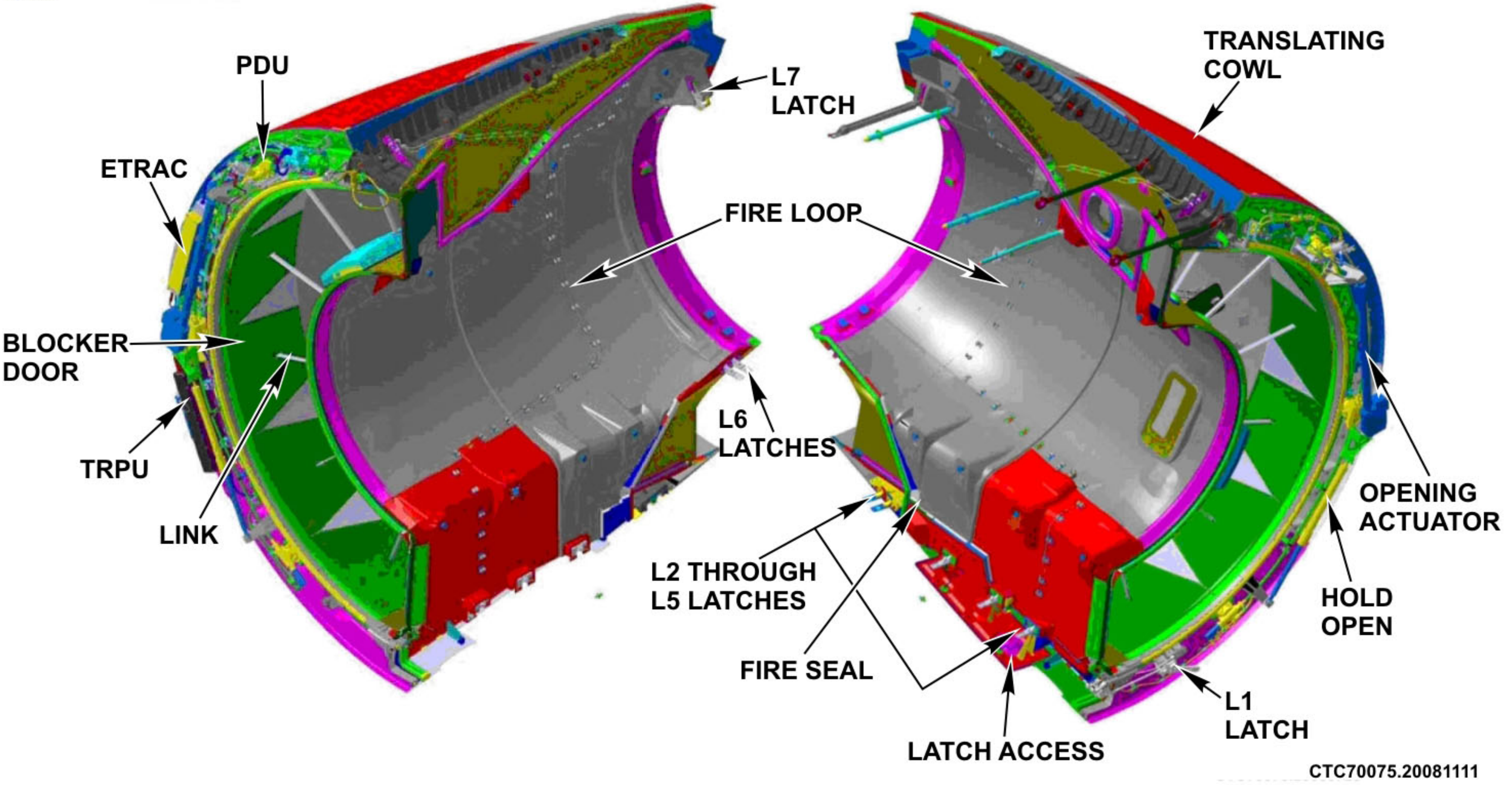
The thrust reverser assembly is located between the fan cowl doors and the exhaust.

Description

The A380 inboard engines are equipped with thrust reverser cowl doors. (Outboard engines are equipped with fan exhaust cowls).
The thrust reverser cowl doors are attached to the wing pylon by four hinges. Two hinges are attached to floating rods.
The thrust reverser assembly is a cascade type thrust reverser with translating cowls and blocker doors.
It is made of two halves that make a duct around the engine core. Each half consists of a fixed structure, which provides support for the cascades and actuation system, and a translating cowl.
The thrust reverser halves open at 6 o'clock and rotate around the 12 o'clock hinge beam to give access to the engine during maintenance operations.

LRUs

Thrust reverser / FEC halves,
Latch access panel
Latch L1,
Latches (L2 to L6),
Latch L7 assembly,
Opening actuators,
Power Cowl Opening System (PCOS) switch box (attached to engine fan case)
Hold open rods,
Translating cowls,
Cascades,
Blocker doors and links,
Electrical Thrust Reverser Actuation Controller (ETRAC ®)
Thrust Reverser Power Unit (TRPU),
Power Drive Unit PDU,
Thrust reverser actuator access panels (3 per side),
Thrust reverser actuators,
Primary COS Power Unit (PCPU)
Fire loop,
Fire seals.


PDU
L7
LATCH
TRANSLATING
COWL
ETRAC
FIRE LOOP
BLOCKER
DOOR
TRPU
LINK
L6
LATCHES
OPENING
ACTUATOR
HOLD
OPEN
L2 THROUGH
L5 LATCHES
FIRE SEAL
L1
LATCH
LATCH ACCESS
CTC70075.20081111

THRUST REVERSER COWL DOORS - GENERAL - PURPOSE ... LRUS

NACELLE DESCRIPTION (EA) (3)

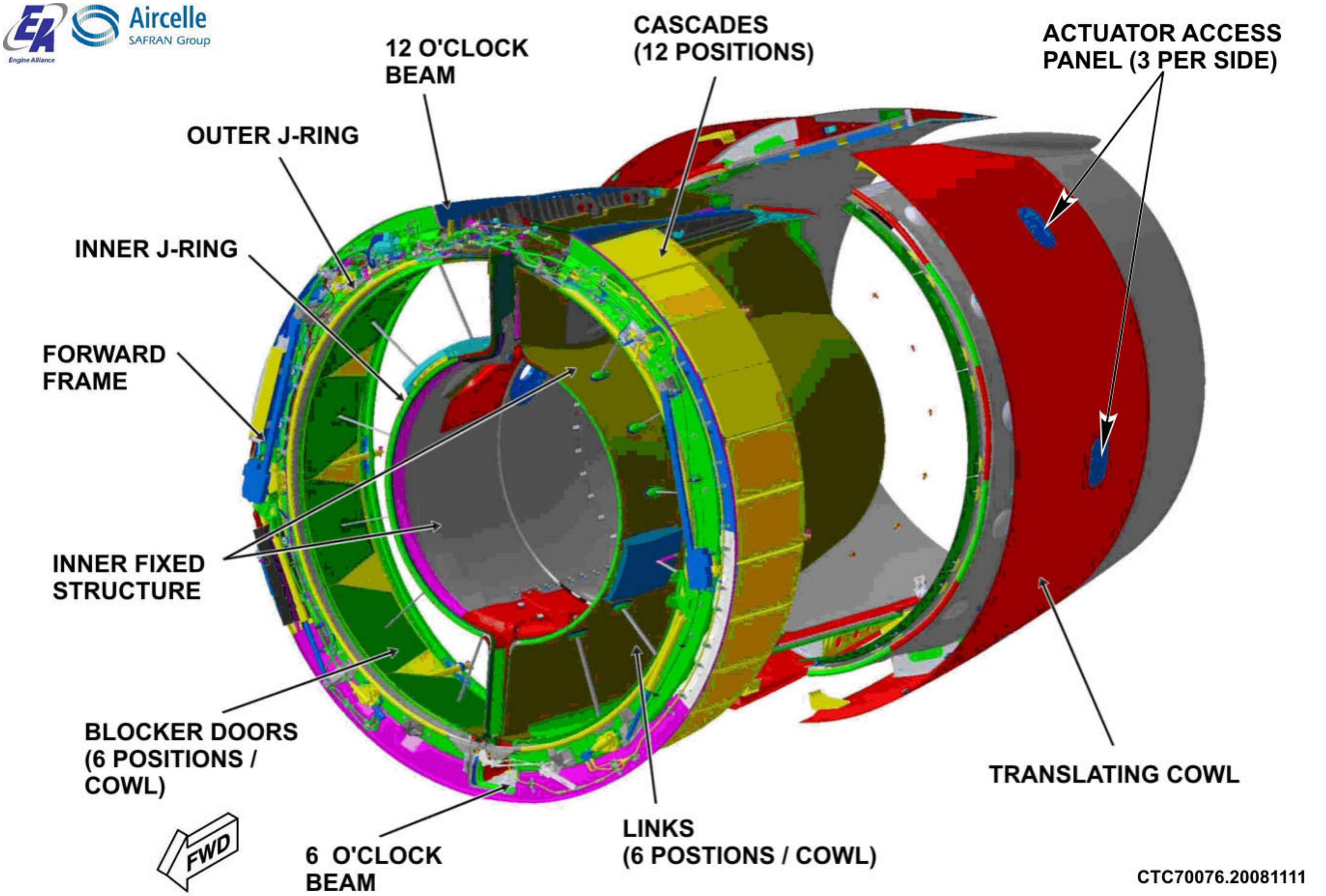
Thrust Reverser Cowl Doors - Doors Structure

Purpose

The thrust reverser structure is composed of fixed structure (outer and inner fixed structure) and the translating cowl.

Components

Fixed structure:
- The outer fixed structure assembly is composed of the following components:
. Forward frame,
. J-rings (inner and outer),
. Cascades assembly (12 cascades).
- The inner fixed structure assembly is composed of the following components:
. 12 o'clock hinge beam,
. 6 o'clock latches beam,
. Inner fixed structure (IFS).
The translating structure is composed of the following components:
- Translating cowl (includes two translating sleeves),
- Blocker door and links (six per translating cowl),
- Actuator access panels (three per translating cowl)


12 O'CLOCK BEAM
CASCADES (12 POSITIONS)
ACTUATOR ACCESS PANEL (3 PER SIDE)
OUTER J-RING
INNER J-RING
FORWARD FRAME
INNER FIXED STRUCTURE
BLOCKER DOORS (6 POSITIONS / COWL)
FWD
6 O'CLOCK BEAM
LINKS (6 POSTIONS / COWL)
TRANSLATING COWL
CTC70076.20081111

THRUST REVERSER COWL DOORS - DOORS STRUCTURE - PURPOSE & COMPONENTS

NACELLE DESCRIPTION (EA) (3)

Thrust Reverser Cowl Doors - Inner Fixed Structure

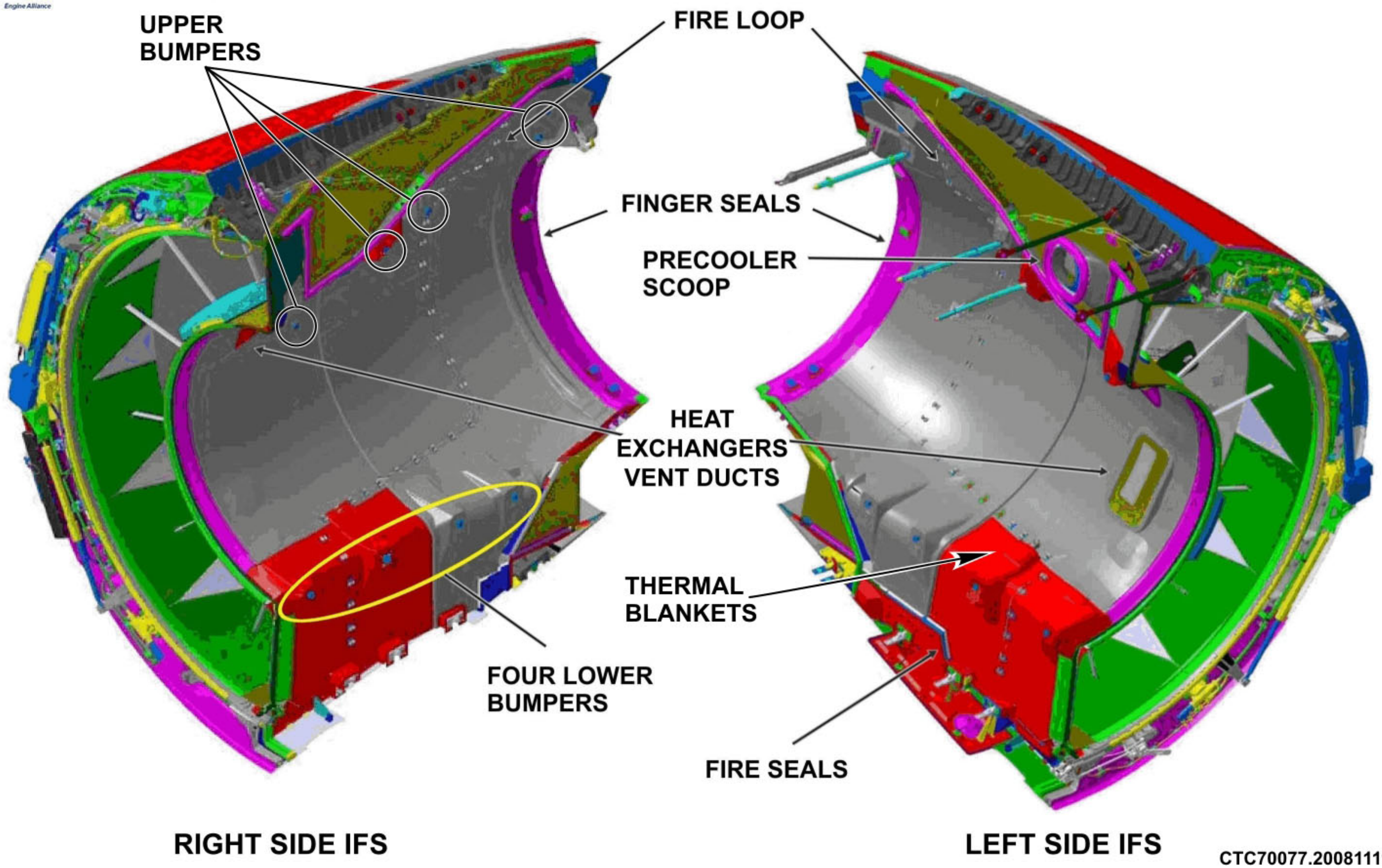
Purpose

The Inner Fixed Structure (IFS) is located around the engine core and provides an aerodynamic inner surface for the fan duct flow.

Description

The IFS is a continuous structure having cutouts to allow air discharge and fan exit air inlet for:
- Precooler scoop (LHS IFS panel),
- Heat exchangers vent ducts

There are four upper and four lower bumpers per cowl
The IFS is equipped with finger seals
The inner surfaces are equipped with thermal blankets, fire loop and fire seals


UPPER BUMPERS
FIRE LOOP
FINGER SEALS
PRECOOLER SCOOP
HEAT EXCHANGERS VENT DUCTS
THERMAL BLANKETS
FOUR LOWER BUMPERS
FIRE SEALS
RIGHT SIDE IFS
LEFT SIDE IFS

CTC70077.20081111

THRUST REVERSER COWL DOORS - INNER FIXED STRUCTURE - PURPOSE & DESCRIPTION

NACELLE DESCRIPTION (EA) (3)

Thrust Reverser Cowl Doors - Opening System

Purpose

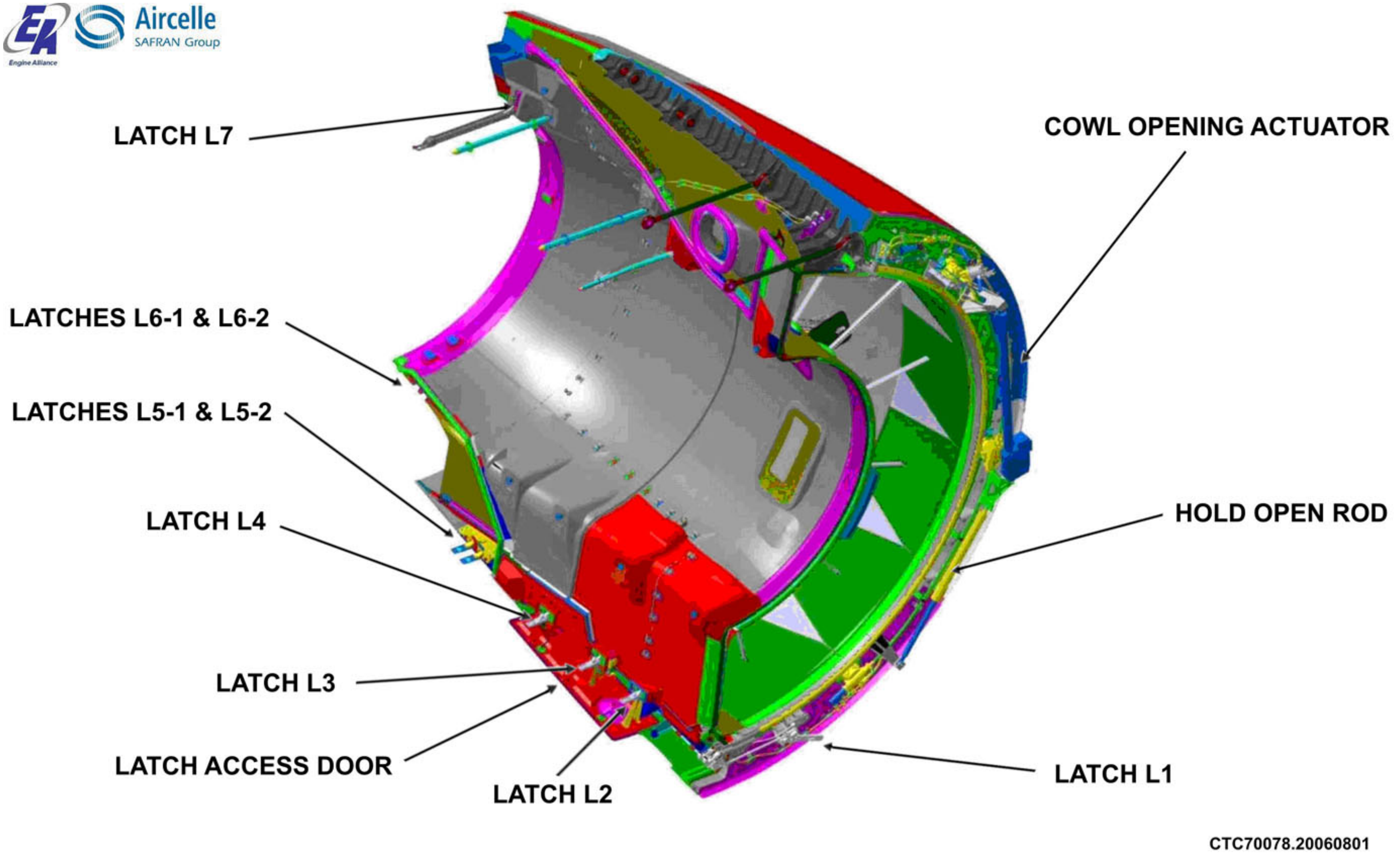
The function of the thrust reverser cowl opening system is to open and to close the thrust reverser cowl doors to gain access for maintenance and servicing.

Components

Latch access door,
Latches L1 to L7,
Cowl opening actuator,
Hold open rod,
Switch box, (attached to engine)
Primary COS Power Unit (PCPU) (attached to engine)

Description

The latches L1 to L7 maintain the halves together.
To have access to the latches L2, L3 and L4, it is necessary to open the 6 o'clock latch access door.
On each forward frame, there are one cowl opening actuator and one Hold Open Rod (HOR).
To operate the cowl opening actuator, you must use a switch box mounted on the engine fan case.
A Primary COS Power Unit (PCPU) converts the electrical power from AC to DC for the opening actuators (fan cowl doors and thrust reverser cowl doors).
The PCPU is located on the top of the fan case.


Engine Alliance
Aircelle
SAFRAN Group
LATCH L7
COWL OPENING ACTUATOR
LATCHES L6-1 & L6-2
LATCHES L5-1 & L5-2
LATCH L4
HOLD OPEN ROD
LATCH L3
LATCH ACCESS DOOR
LATCH L2
LATCH L1
CTC70078.20060801

THRUST REVERSER COWL DOORS - OPENING SYSTEM - PURPOSE ... DESCRIPTION

NACELLE DESCRIPTION (EA) (3)

Thrust Reverser - Latch Access Doors

Purpose

The latch access door gives protection and access to the latches L2, L3 and L4.
It also provides aerodynamic surface of the nacelle.
This door is also a blow -out door, which permits pressure relief in case of over-pressure in the core compartment.

Location

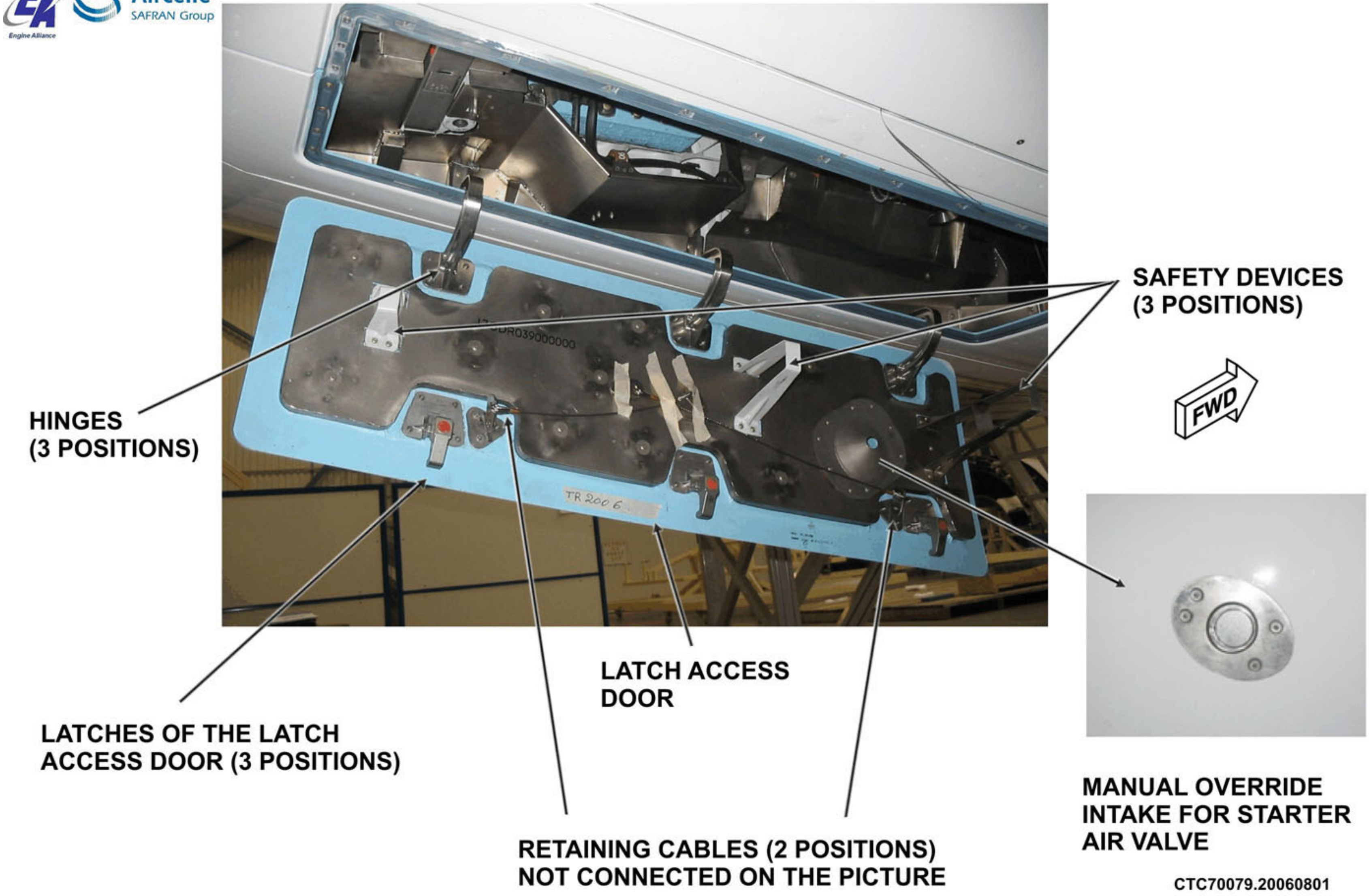
The door is attached to the left thrust reverser at 6 o'clock.

Components

Latch access door,
3 hinge goosenecks,
3 latches,
3 safety devices,
2 retaining cables,
Valve for manual override intake for the starter air valve.

Description

Two retaining cables are installed to hold the latch access door in case of over-pressure to prevent it from flapping.
In order to prevent the maintenance errors the Latch Access Door is equipped with safety devices, to avoid the possibility to close the door if a latch is not properly locked.
There are also three hinges and three latches on the latch access door.


SAFETY DEVICES
(3 POSITIONS)
FWD
HINGES
(3 POSITIONS)
LATCH ACCESS
DOOR
LATCHES OF THE LATCH
ACCESS DOOR (3 POSITIONS)
MANUAL OVERRIDE
INTAKE FOR STARTER
AIR VALVE
RETAINING CABLES (2 POSITIONS)
NOT CONNECTED ON THE PICTURE
CTC70079.20060801

THRUST REVERSER - LATCH ACCESS DOORS - PURPOSE ... DESCRIPTION

NACELLE DESCRIPTION (EA) (3)

Thrust Reverser Cowl Doors - Latches - L1 Through L6-2

Purpose

The latches maintain the halves together.

Location

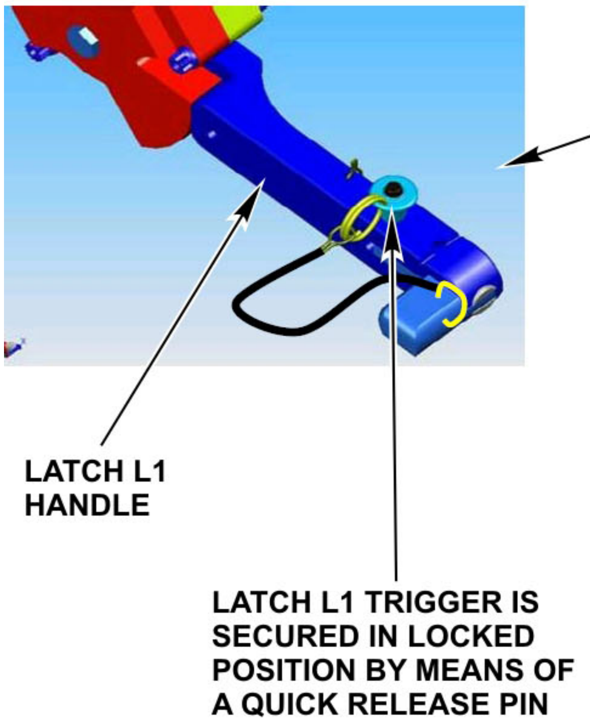
Latch L1 is located on the left forward frame.
Latches L2, L3, L4, L5-1 and L5-2 are located on the bottom split line.
Latches L6-1 and L6-2 are located on the bottom split line of the rear of the inner fixed structure

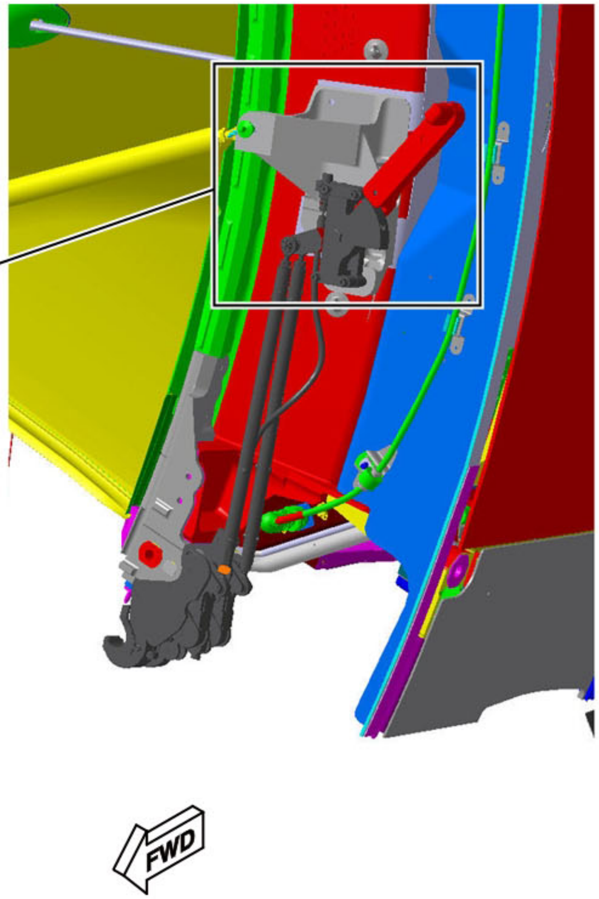
Components

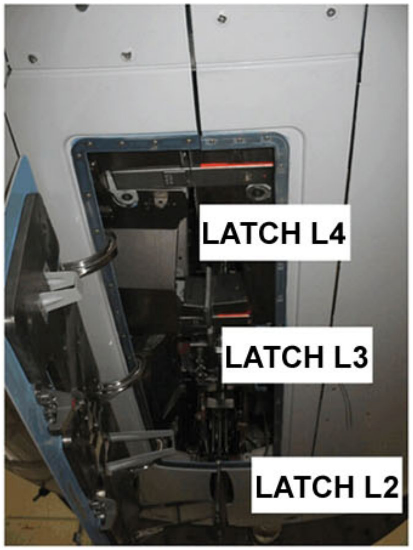
Latch and hook L1,
Latch and hook L2,
Latch and hook L3,
Latch and hook L4,
Latch and hook L5-1,
Latch and hook L5-2,
Latch and hook L6-1,
Latch and hook L6-2.

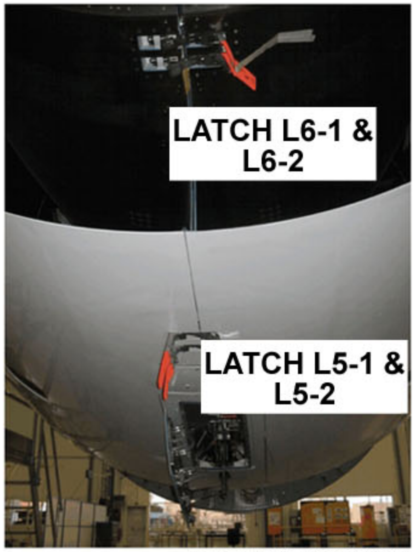
Description

L1 is a 3-points contact latch.
L1 trigger is secured locked by means of a quick release pin on the handle.
Latches L5-1 and L5-2 link the transcowls
L2, L3, L4, L5-1, L5-2, L6-1 and L6-2 are classical tension hook latches.


LATCH L1
HANDLE
LATCH L1 TRIGGER IS
SECURED IN LOCKED
POSITION BY MEANS OF
A QUICK RELEASE PIN




LATCH L4
LATCH L3
LATCH L2


LATCH L6-1 &
L6-2
LATCH L5-1 &
L5-2

CTC70080.20081110

THRUST REVERSER COWL DOORS - LATCHES - L1 THROUGH L6-2 - PURPOSE ... DESCRIPTION

NACELLE DESCRIPTION (EA) (3)

Thrust Reverser Cowl Doors - Latch L7

Purpose

L7 is a special latch that links the two inner fixed structures at 12 0'oclock.
The latch L7 is linked to the latch L6-2.

Location

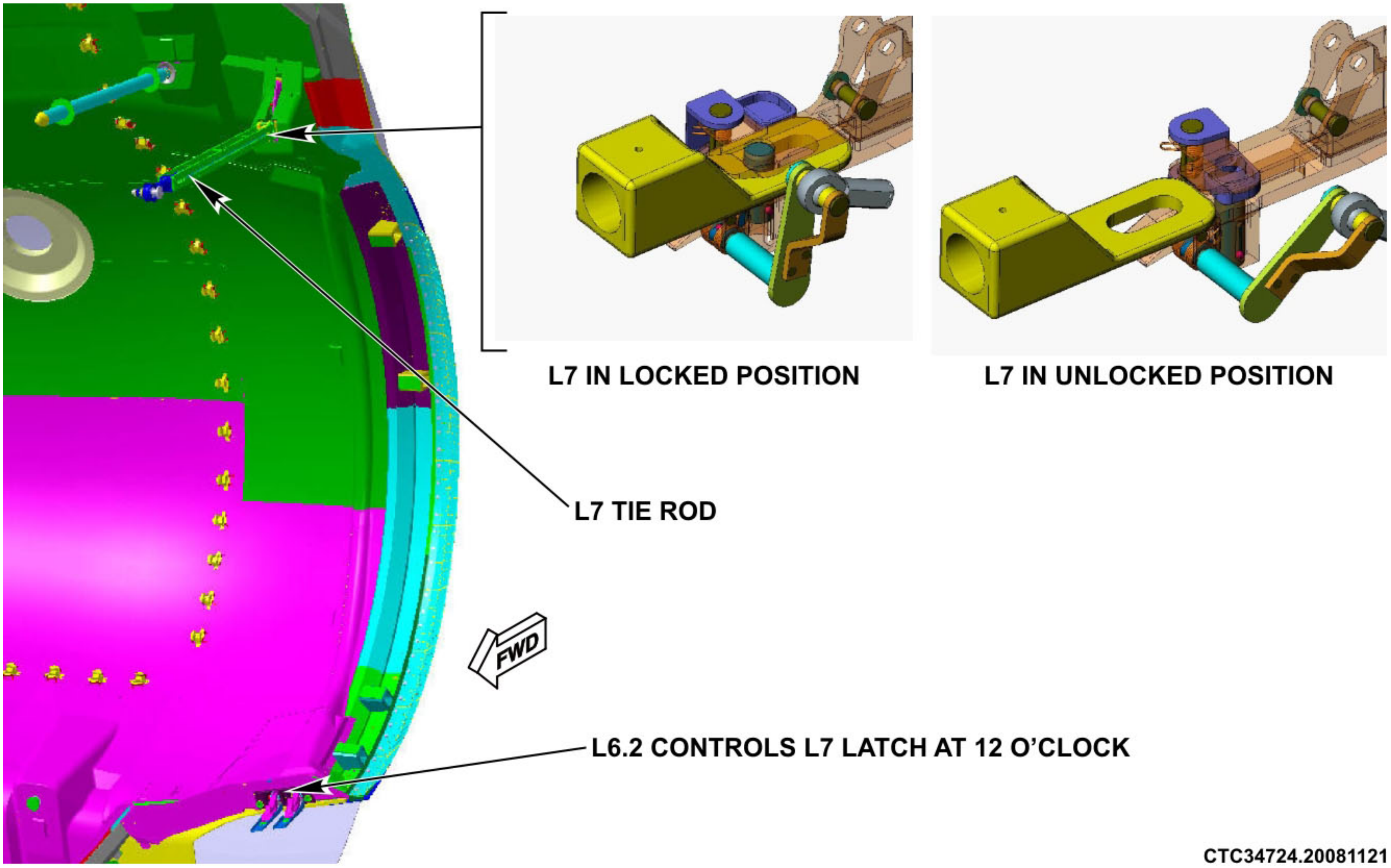
It is located on the rear of the IFS at 12:30 position

Components

Push-pull cable,
Latch L7,
L7 telescopic tie rod.

Description

At 12 o'clock, the latch L7 tie rod links the two inner fixed structures.
A push pull cable links latch L6.2 to the latch L7 telescopic tie rod mechanism.
The L7 fitting is removable from the exterior of the inner fixed structure in case of L7 jamming.


L7 IN LOCKED POSITION
L7 IN UNLOCKED POSITION
L7 TIE ROD
FWD
L6.2 CONTROLS L7 LATCH AT 12 O'CLOCK
CTC34724.20081121

THRUST REVERSER COWL DOORS - LATCH L7 - PURPOSE ... DESCRIPTION

NACELLE DESCRIPTION (EA) (3)

Thrust Reverser Cowl Doors - Opening Actuator

Purpose

The opening actuator allows opening the cowl door to 35° and 45° opening positions.

Location

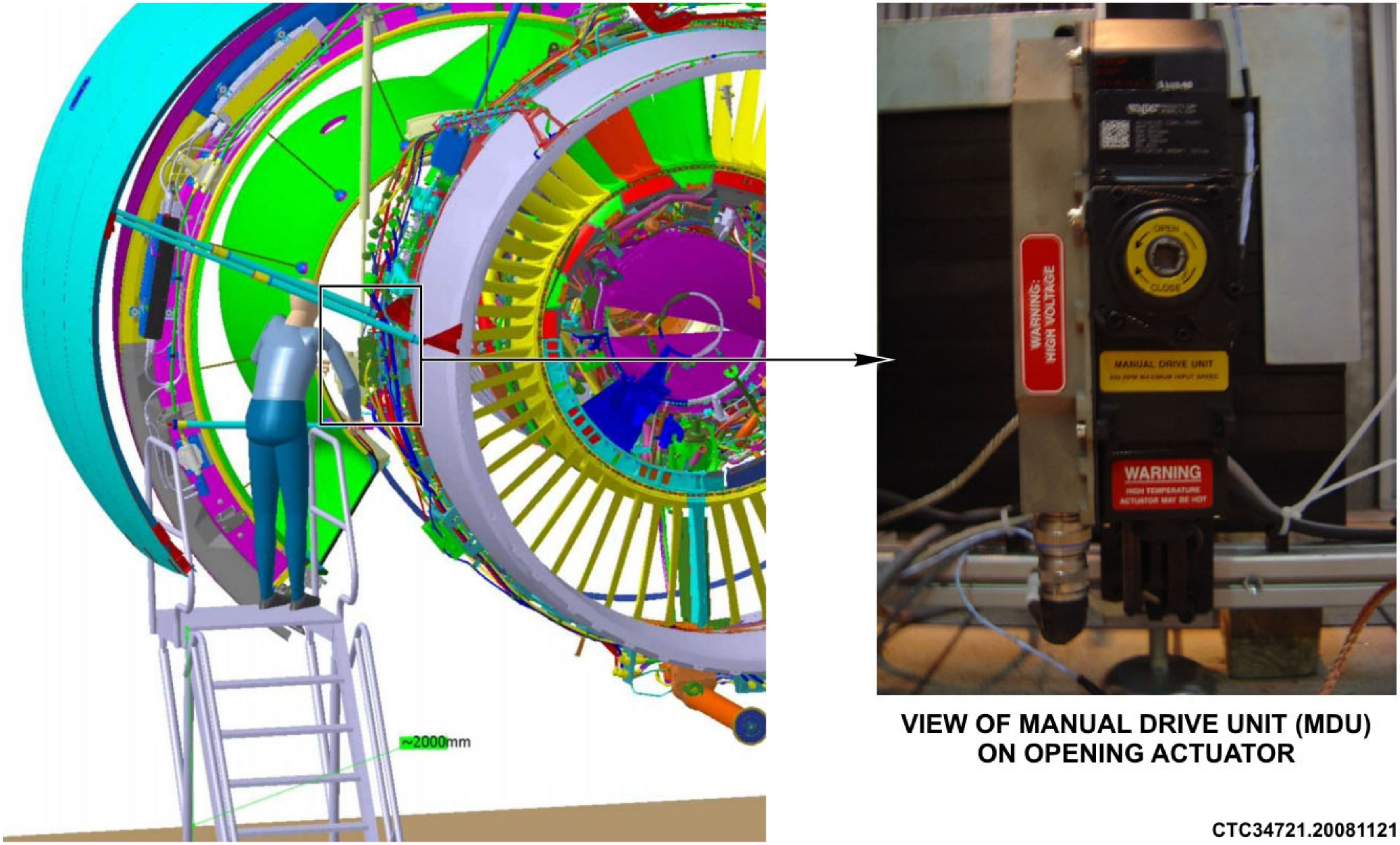
The opening actuator is attached to the fan case at 3 and 9 o'clock, and connected to the thrust reverser forward frame.

Components

The opening actuator,
The switch box and its harnesses.

Description

This electrical opening actuator is controlled from a switch box installed on the engine fan case at 7 o'clock and 4 o'clock.
The opening actuator is equipped with a Manual Drive Unit (MDU) that can be used when electrical power is off.
The manual drive unit is a 3/8" square drive. It could be operated with a power wrench (500 RPM maximum).


~2000mm
WARNING: HIGH VOLTAGE
OPEN
CLOSE
MANUAL DRIVE UNIT
WARNING
HIGH TEMPERATURE
ACTUATOR MAY BE HOT

VIEW OF MANUAL DRIVE UNIT (MDU)
ON OPENING ACTUATOR

CTC34721.20081121

THRUST REVERSER COWL DOORS - OPENING ACTUATOR - PURPOSE ... DESCRIPTION

NACELLE DESCRIPTION (EA) (3)

Thrust Reverser Cowl Doors - Hold Open Rod

Purpose

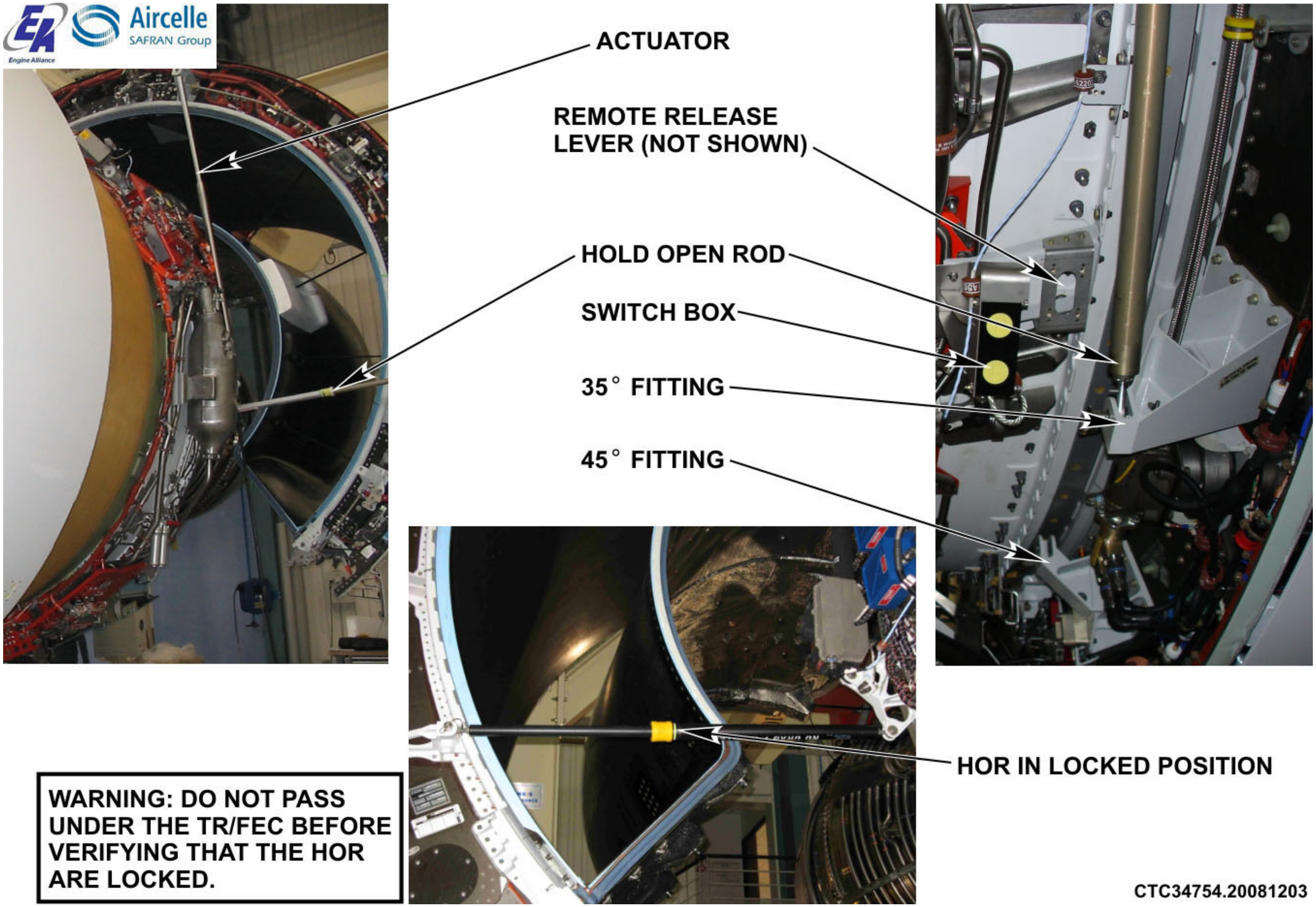
Each thrust reverser cowl door opens and is maintained in the opened position by one hold open rod.

Location

The ends of the hold open rod are attached to a 35° fitting on the thrust reverser cowl door forward frame and to a bracket on the fan case at 3:30 and 8:30 position.

Description

Two opening positions: 35° and 45°.
The hold open rod keeps the thrust reverser cowl door in the opened position for ground maintenance.
The 35° fitting is the storage fitting.
It is necessary to move the hold open rod on a second forward frame fitting to open the thrust reverser cowl door to the 45° position.
The other means of retention is the cowl door opening actuator.


Engine Alliance
Aircelle
SAFRAN Group
ACTUATOR
REMOTE RELEASE LEVER (NOT SHOWN)
HOLD OPEN ROD
SWITCH BOX
35° FITTING
45° FITTING
HOR IN LOCKED POSITION
CTC34754.20081203

WARNING: DO NOT PASS UNDER THE TR/FEC BEFORE VERIFYING THAT THE HOR ARE LOCKED.

THRUST REVERSER COWL DOORS - HOLD OPEN ROD - PURPOSE ... DESCRIPTION

NACELLE DESCRIPTION (EA) (3)

Thrust Reverser Cowl/Fan Exhaust Cowl Door Opening/Closing

Purpose

The cowl doors must be opened to get access to the core compartment for maintenance or servicing.

Description and Operation

You must have electric power before you use the actuator.
It is the same procedure for Fan Exhaust Cowls (FEC)
There are two opening angle positions, 35° and 45°.
It is necessary to open at 45°:
- For engine:
. To reach upper components installed between 2 and 10 o'clock,
. To remove and install the engine.
- For nacelle:
. To remove/install upper thermal blankets,
. To remove/install latch L7 assembly and telescopic tie rod,
. To remove/install the upper thrust reverser seals,
. To inspect all these components and all inner upper areas.

Procedure

35° opening of the cowl doors:
- Make sure the area around the engine is clear,
- Make sure that the fan cowl doors are open at 49°,
- Open the 6 o'clock latch access door,
- Open the latches following the latches opening sequence: L1 - L6.2 - L6.1 - L5.2 - L5.1 - L4 - L3 - L2,
- Push the UP button to open the cowl doors until the hold open rod automatically locks (green locking flags appear),
- When the hold open rod is locked, push on the DOWN button to release the loads from the opening actuator and hold the cowl door weight on the hold open rods.

WARNING: Do not pass under the cowl doors before verifying that the hold open rods are locked.

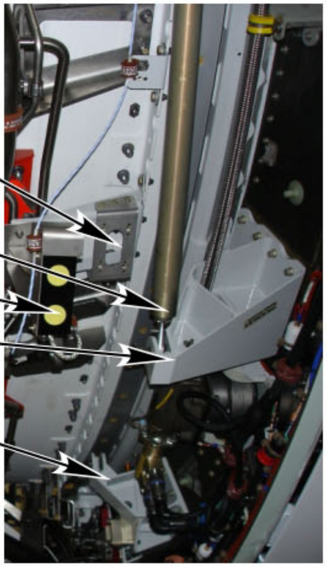
45° opening of the cowl doors:

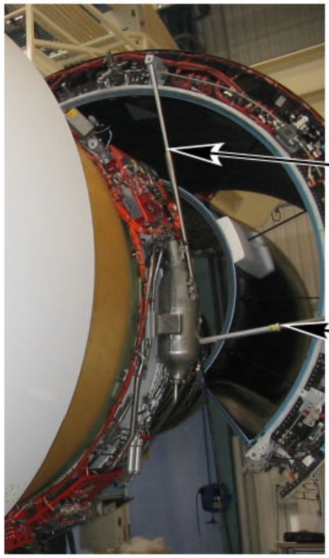
CAUTION: Slats must be retracted and inhibited to avoid possible interferences in case of cowl opening to 45 degrees.

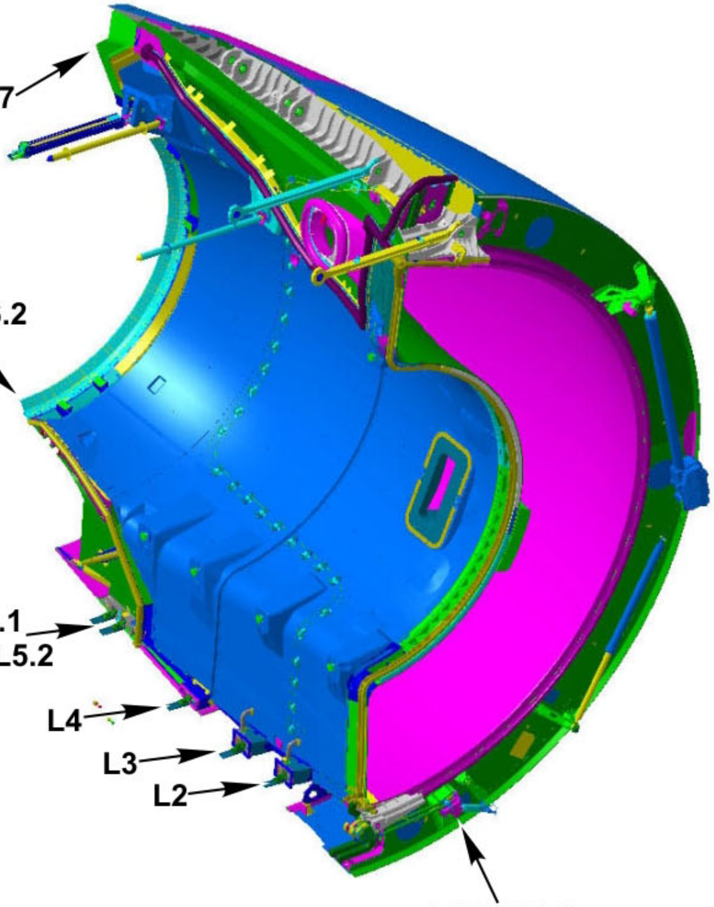
- The cowl door must already be opened at 35°,
- The fan cowl door must be opened at 49°,
- Push on the UP button of the switch box to release the loads from the hold open rods,
- Relocate the cowl door hold open rod to the 45° fitting.

WARNING: Nobody under the cowl door during operation. Do not push any button when a hold open rod is disconnected.

- Push on the UP button to fully open the cowl door to 49°,
- Cowl door opening is stopped by the hold open rod locking,
- When the hold open rod is locked (green locking flag appears), push on the DOWN button to release the loads from the opening actuator and hold the cowl door weight on the hold open rod.


REMOTE RELEASE LEVER (NOT SHOWN)
HOLD OPEN
SWITCH BOX
35° FITTING
45° FITTING


ACTUATOR
HOLD OPEN ROD


L7
L6.1 & L6.2
L5.1 & L5.2
L4
L3
L2
LATCH L1

LATCHES OPENING SEQUENCE: L1 - L6.2 - L6.1 - L5.2 - L4 - L3 - L2

CTC34769.20081205

THRUST REVERSER COWL/FAN EXHAUST COWL DOOR OPENING/CLOSING - PURPOSE ... PROCEDURE

NACELLE DESCRIPTION (EA) (3)

Thrust Reverser Cowl/Fan Exhaust Cowl Door Opening/Closing (continued)

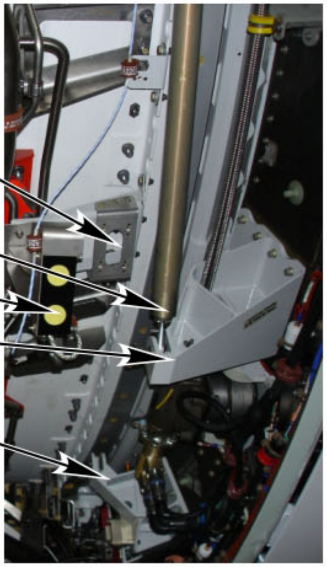
Procedure (Continued)

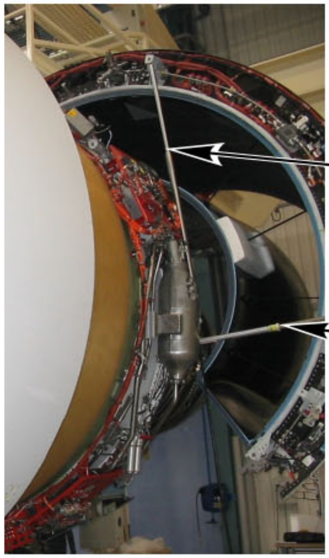
Closing the cowl doors from the 45° position:
- The cowl door must already be opened at 45°,
- Push on the UP button to release the loads from the Hold Open Rod (HOR),
- Operate the remote release lever to unlock the HOR,
- Push on the DOWN button to close the cowl door to an angle of about 35°,
- Relocate the cowl door hold open rod end to the 35° fitting.

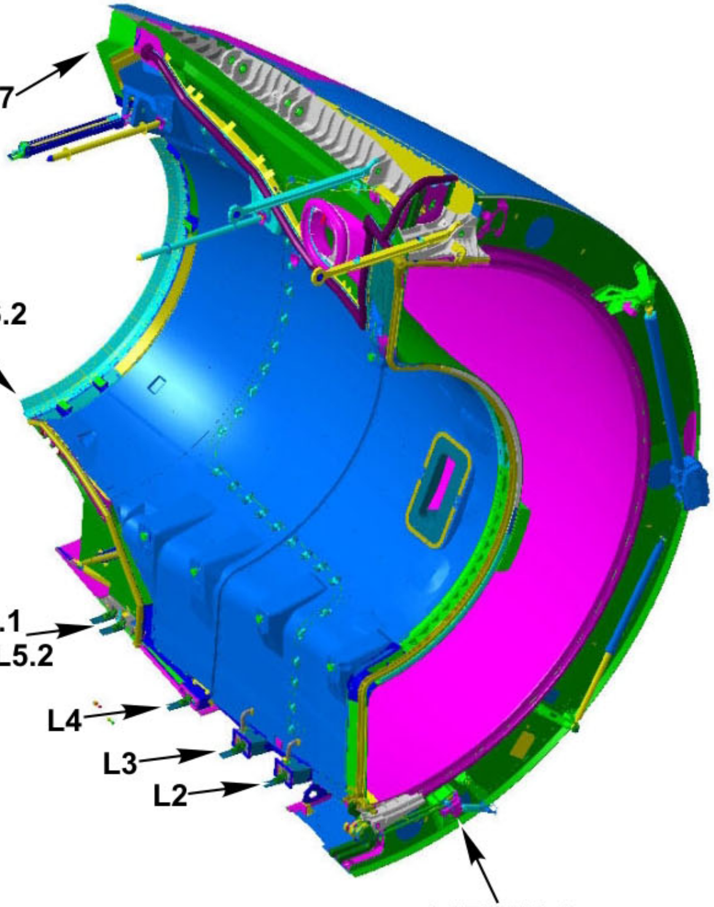
WARNING: Nobody under the cowl during operation.
Do not push any button when a hold open rod is disconnected.

- Push on the DOWN button until the complete closure of the cowl door,
- Latch the cowl doors using the following latch closing sequence: L2 - L3 - L4 - L5.1 - L5.2 - L6.1 - L6.2 - L1,
- Close the 6 o'clock latch access door.

Closing the Cowl Doors from the 35° position:
- Push on the UP button to release the loads from the hold open rod,
- Operate the remote release lever to unlock the HOR,
- Push on the DOWN button until the complete closure of the cowl door,
- Latch the cowl doors using the following latch closing sequence: L2 - L3 - L4 - L5.1 - L5.2 - L6.1 - L6.2 - L1,
- Close the 6 o'clock latch access door.


REMOTE RELEASE LEVER (NOT SHOWN)
HOLD OPEN
SWITCH BOX
35° FITTING
45° FITTING


ACTUATOR
HOLD OPEN ROD


L7
L6.1 & L6.2
L5.1 & L5.2
L4
L3
L2
LATCH L1

LATCHES CLOSING SEQUENCE: L2 - L3 - L4 - L5.1 - L5.2 - L6.1 - L6.2 - L1

CTC34770.20081205

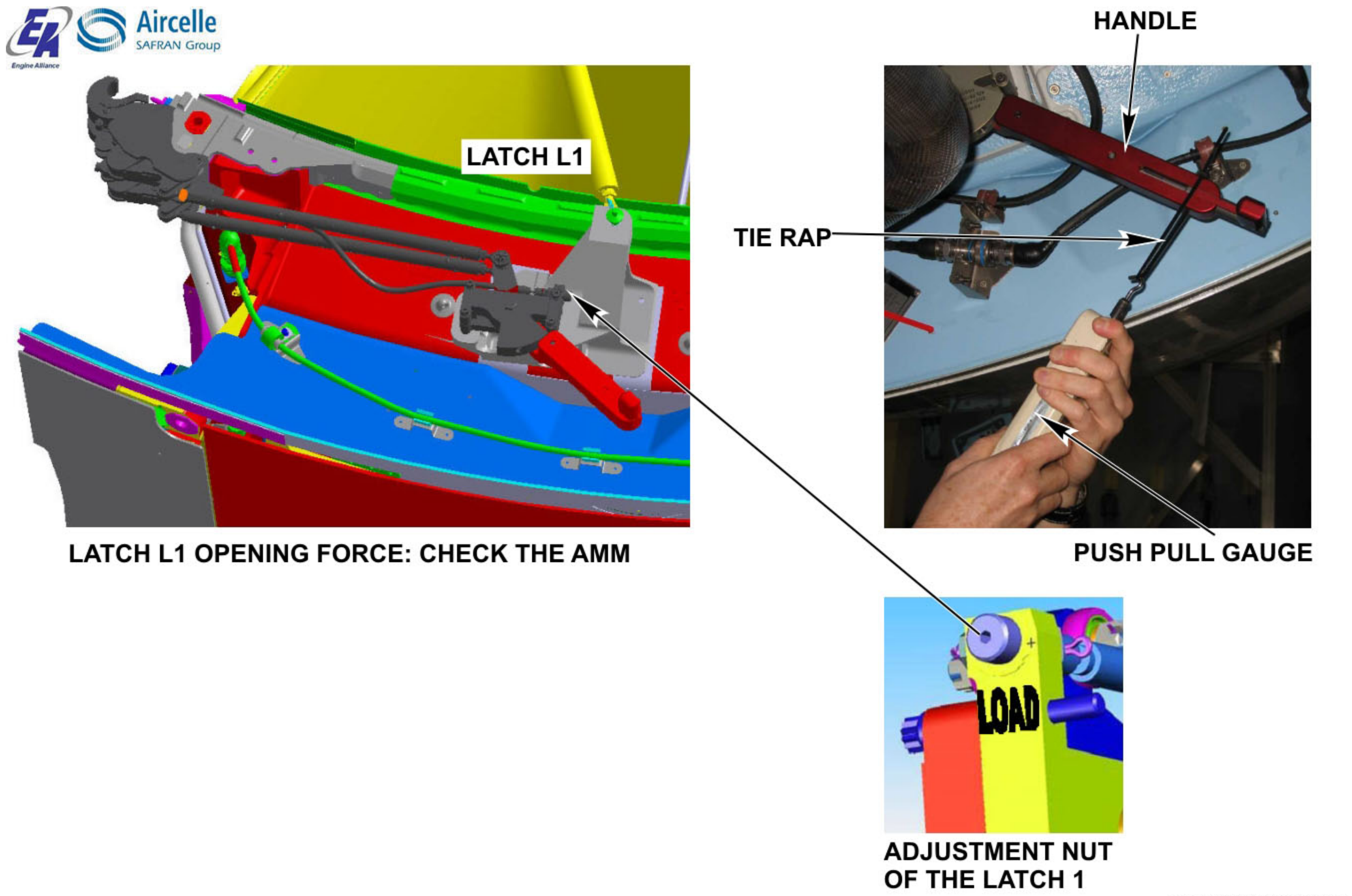
THRUST REVERSER COWL/FAN EXHAUST COWL DOOR OPENING/CLOSING - PROCEDURE (CONTINUED)

NACELLE DESCRIPTION (EA) (3)

Thrust Reverser Cowl Doors latches rigging

Procedure

Adjustment of the Latch L1 tension:
- Check that all the latches are fully closed
- Measure the applied force to open the latch L1 with a push - pull gage
- The force needed to open the latch L1 must be between 24 and 30 daN (54 and 67 lbf) check the AMM If the force is not correct, adjust he latch tension as follows:
- Close the latch
- Turn the tension nut clockwise to increase the tension and counter clockwise to decrease the tension
- Check the force to open the latch with a push - pull gage
- Repeat this procedure to get the required tension on the latch handle
- Check that the handle trigger is correctly engaged in its slot.


Aircelle
SAFRAN Group
Engine Alliance
LATCH L1
HANDLE
TIE RAP
LATCH L1 OPENING FORCE: CHECK THE AMM
PUSH PULL GAUGE
LOAD
ADJUSTMENT NUT
OF THE LATCH 1

CTC34725.20081121

THRUST REVERSER COWL DOORS LATCHES RIGGING - PROCEDURE

NACELLE DESCRIPTION (EA) (3)

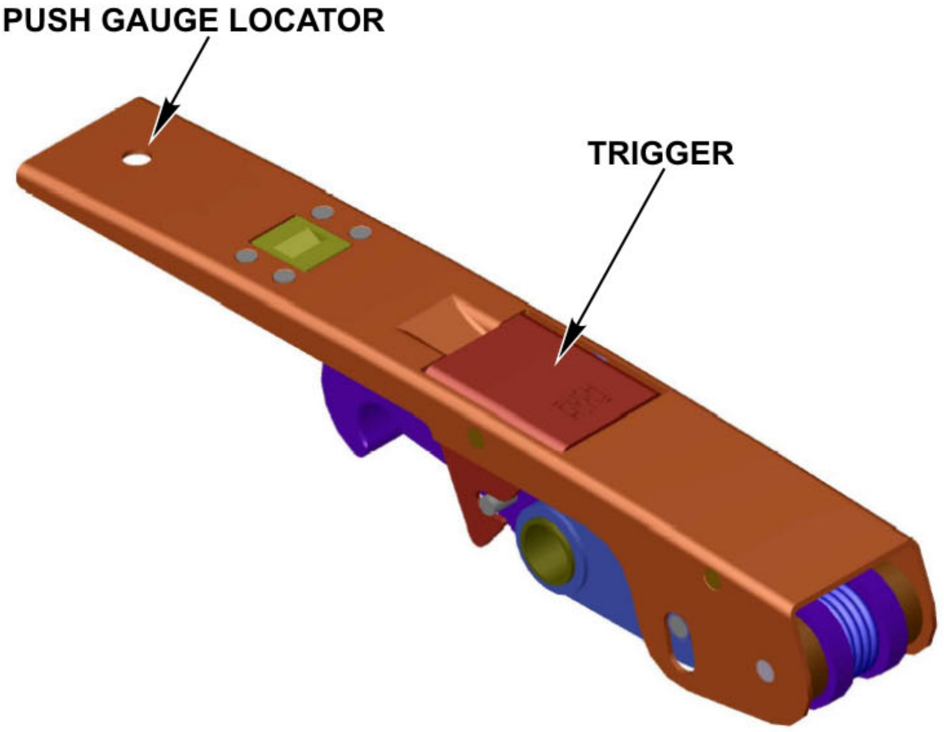
Thrust Reverser Cowl Doors latches rigging (continued)

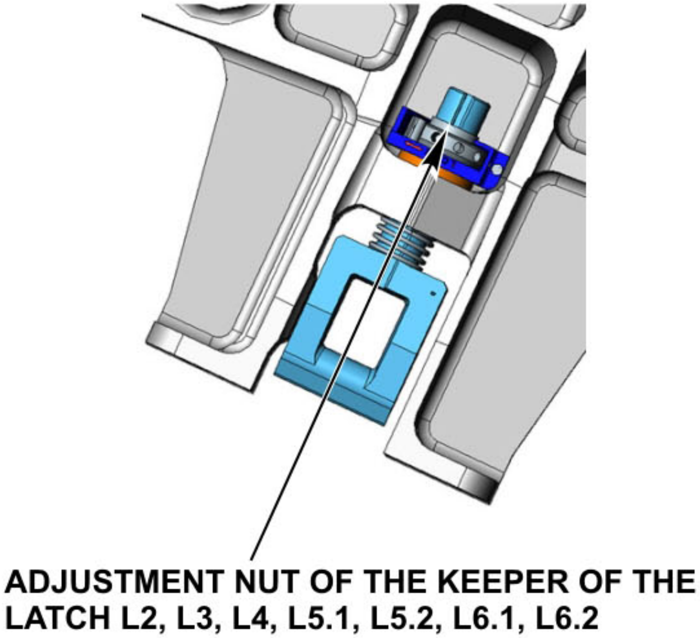
Procedure (Continued)

Adjustment of the latches L2, L3, L4, L5.1, L5.2, L6.1 and L6.2
- Open the latch access door (not for L1, L5.1, L5.2, L6.1, L6.2)
- Check that all latches are fully closed.
- Open the latch to be checked
- Measure the applied force needed to close the latch with a push-pull gage
- The force needed to close the latches L2, L3, L4, L5.1 and L5.2 must be between 12 and 20 daN (27 and 45 lbf) Check the AMM
- The force needed to close the latches L6.1, L6.2 must be between 11 and 16 daN (25 and 36 lbf). Check the AMM

If the force is not correct, adjust the latch tension as follows:
- Open the latch to be checked
- Push the keeper to disengage the tension nut from the locking pin
- Turn the tension nut clockwise to increase the tension and counter clockwise to decrease the tension.
- Check the force needed to close the latch with a push-pull gage
- Repeat this procedure to get the required tension on the latch.

LB408521 - L5CT0T0 - LM7E9Z000000001


PUSH GAUGE LOCATOR
TRIGGER


ADJUSTMENT NUT OF THE KEEPER OF THE LATCH L2, L3, L4, L5.1, L5.2, L6.1, L6.2

LATCHES L2, L3, L4, L5.1 AND L5.2 CLOSING FORCE: CHECK AMM
LATCHES L6.1 AND L6.2 CLOSING FORCE: CHECK AMM

CTC34726.20081121

THRUST REVERSER COWL DOORS LATCHES RIGGING - PROCEDURE (CONTINUED)

NACELLE DESCRIPTION (EA) (3)

Fan Exhaust Cowls - General

Purpose

This component is dedicated to be installed on the outboard nacelles.
This component does not include the Thrust Reverse system.

Location

Same as the Thrust Reverser Cowl Doors.

Components

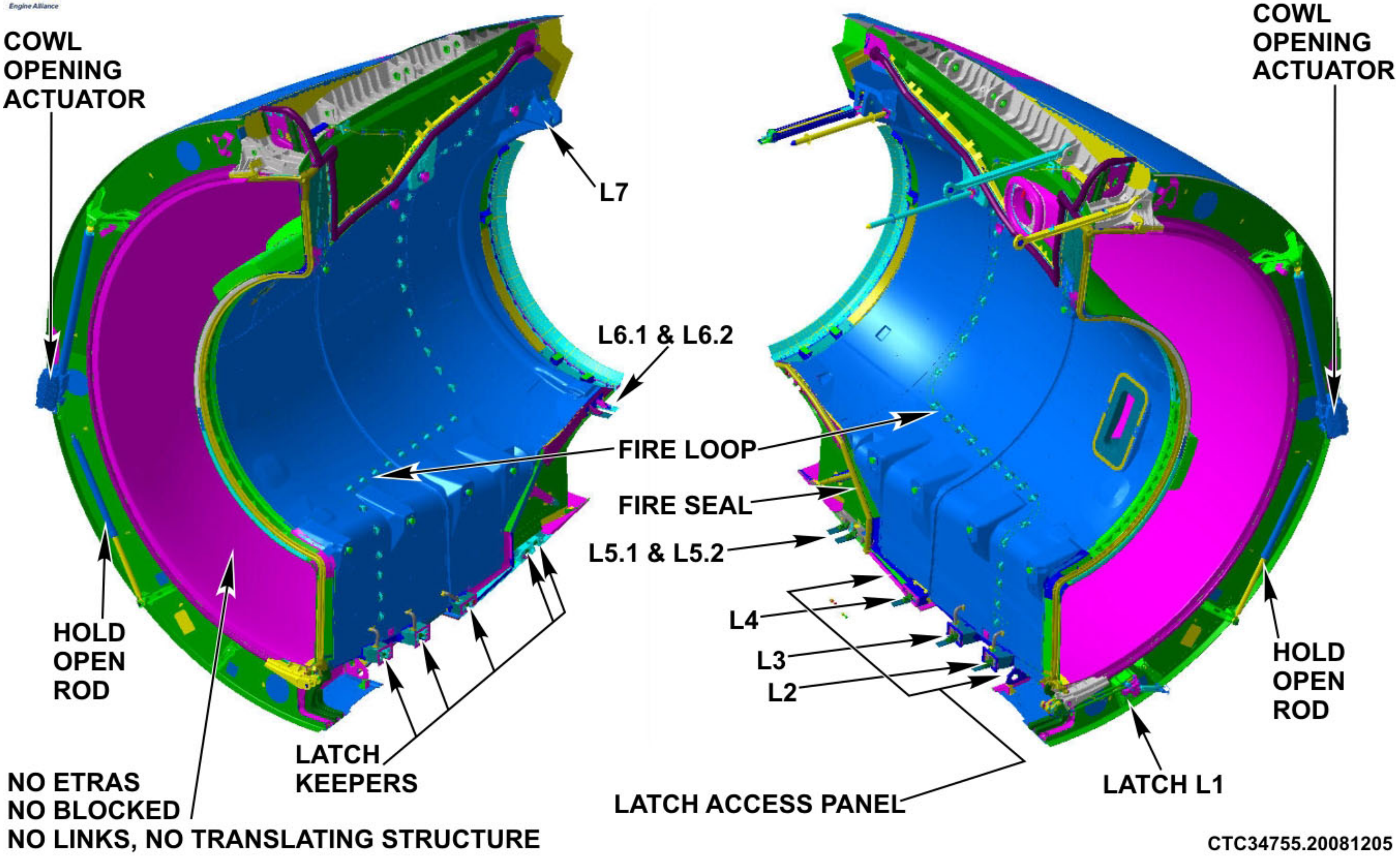
Same as the Thrust Reverser Cowl Doors in exception of:
- No ETRAS ®,
- No blocker doors and links,
- No translating structure.

Description

The Fan Exhaust Cowls (FEC) share the same external interfaces as the Thrust Reverser.

LRUs

FEC Halves,
Latch access panel
Latch L1,
Latches (L2 to L6) and keepers,
Latch L7 Assembly,
Opening actuators,
PCPU
PCOS Harnesses,
PCOS Switches,
Hold Open Rods,
Fire loop,
Fire seals.


COWL OPENING ACTUATOR
L7
COWL OPENING ACTUATOR
L6.1 & L6.2
FIRE LOOP
FIRE SEAL
L5.1 & L5.2
L4
L3
L2
HOLD OPEN ROD
HOLD OPEN ROD
LATCH KEEPERS
NO ETRAS
NO BLOCKED
NO LINKS, NO TRANSLATING STRUCTURE
LATCH ACCESS PANEL
LATCH L1
CTC34755.20081205

FAN EXHAUST COWLS - GENERAL - PURPOSE ... LRUS

NACELLE DESCRIPTION (EA) (3)

Exhaust Nozzle & Plugs - General

Purpose

It is an acoustically treated structure that provides flow contour for engine exhaust gas.

Location

On the rear of the Thrust Reverser Cowl Doors.

Components

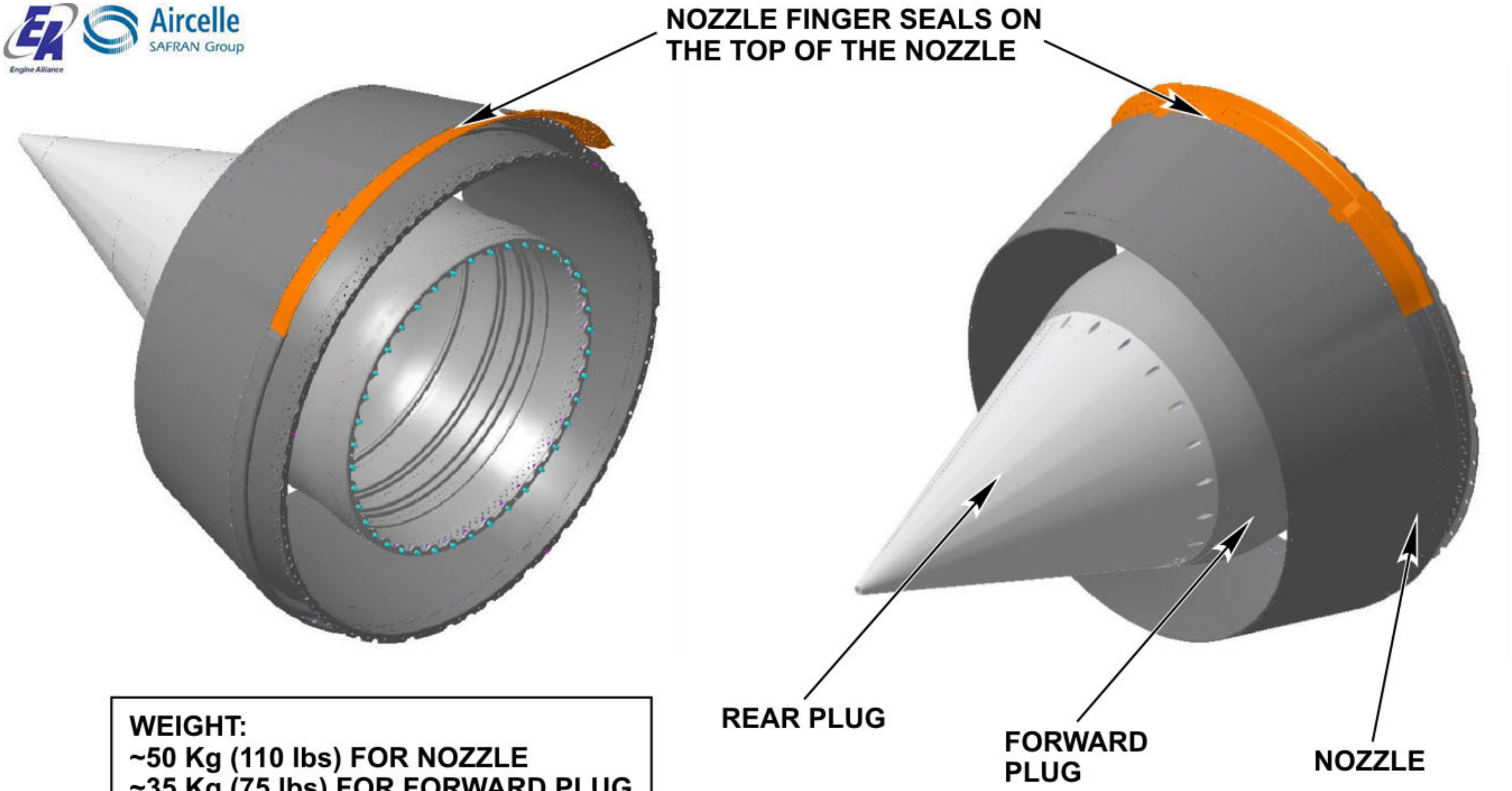
Nozzle,
Front Plug,
Rear Plug.

Description

The exhaust system is composed of two parts, the nozzle and the plugs (rear and front).
The upper part of the nozzle is equipped with finger seals, which are fire seals.
There are three spigots on the nozzle.
Spigots are locators and ease the nozzle removal and installation.

LRUs

Nozzle,
Front Plug,
Rear Plug.


NOZZLE FINGER SEALS ON THE TOP OF THE NOZZLE
REAR PLUG
FORWARD PLUG
NOZZLE

WEIGHT:
~50 Kg (110 lbs) FOR NOZZLE
~35 Kg (75 lbs) FOR FORWARD PLUG
~15 Kg (35 lbs) FOR REAR PLUG

CTC34753.20081202

EXHAUST NOZZLE & PLUGS - GENERAL - PURPOSE ... LRUS

ENGINE COWLING DESCRIPTION (2)

Fan Cowl

Opening

The fan cowl doors can be opened for maintenance functions on the engine. The unlatching sequence is carried out from the latch access panel located at the split line between the two fan cowl doors.
Unlocking of the four latches is done in a defined sequence: L2 first, L3, L1 and L4 at the end. Once the fan cowl doors are unlocked, the opening is done from the fan cowl P/B control switches installed on the air intake cowl, at the RH and LH sides of the engine. The maintenance personnel must push and hold the UP switch until the fan cowl door has reached the desired position. The Hold Open Rods (HORs) are automatically locked. When a HOR is locked the green indicator is visible in the full open position. Then the maintenance personnel must push the DOWN switch to hold the cowl on the HORs.
The fan cowl doors have two open positions:
- intermediate position of 41 degrees,
- full open position of 49 degrees.

The fan cowl doors can be directly opened from zero to the full open position.

NOTE: There are three flag indicators to know the HOR state:
- red indicator, unlocked between 0º and 41º positions,
- no color indicator, locked on 41º position and unlocked between 41º and 49º positions,
- green indicator, locked at 49º position.

Human factor points:

CAUTION: -MAKE SURE THAT THE WIND SPEED CONDITIONS ARE NOT MORE THAN 45 KNOTS.
-BEFORE YOU FULLY OPEN THE FAN COWLS, MAKE SURE THAT SLATS ARE RETRACTED AND THAT THEY CANNOT MOVE FROM POSSIBLE INTERFERENCES.

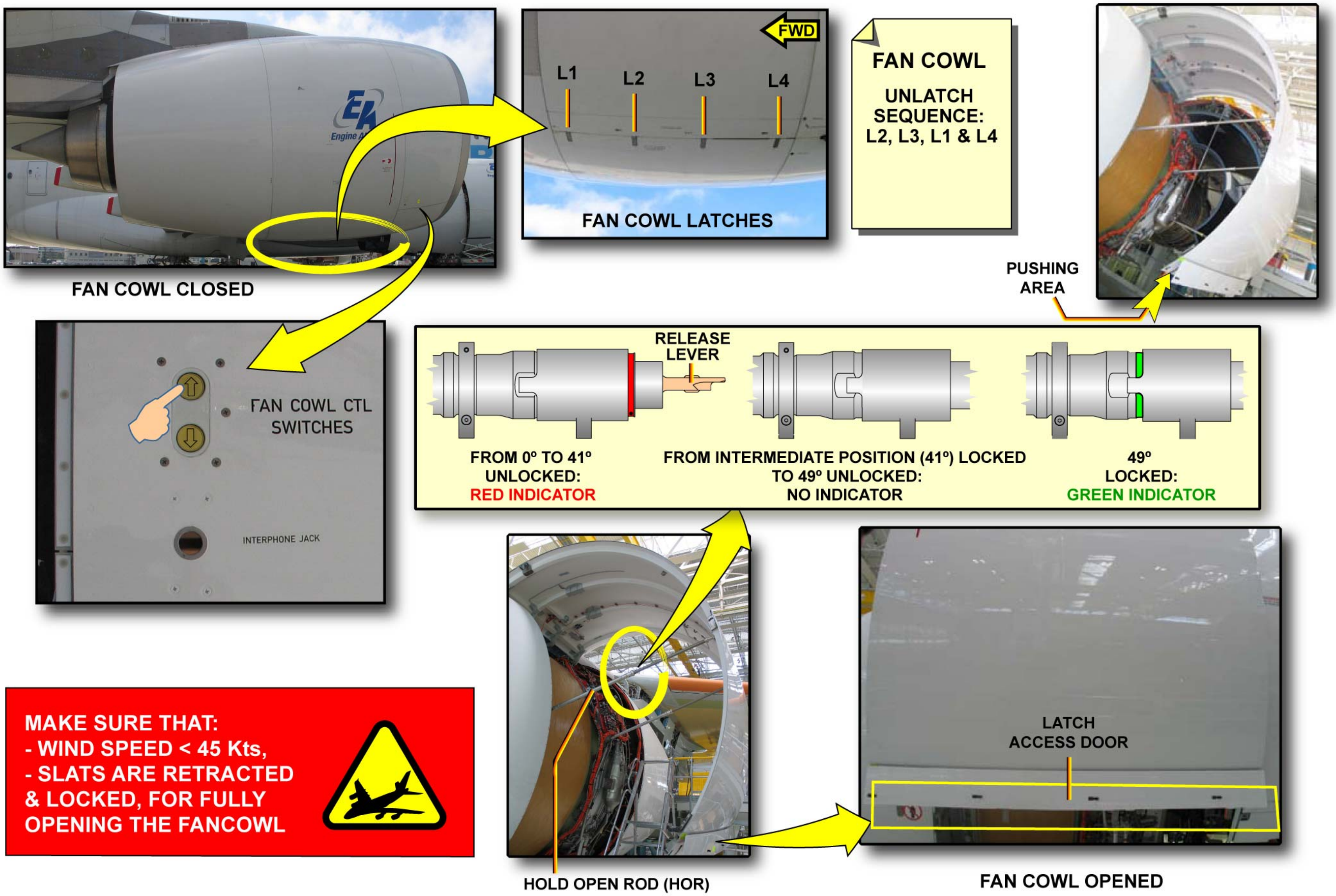
Closing

At the end of maintenance tasks on the engine, the fan cowl doors have to be closed to put the aircraft back into operation. First of all, the maintenance personnel must push the UP switch momentarily and operate the HOR release lever on the HOR to manually unlock it. When the HOR is unlocked, the red indicator is visible. Then he has to push and hold the DOWN switch until the fan cowl door closes completely. The locking of the four latches is done in a defined sequence:
- L4 first,
- L1,
- L3,
- and L2 at the end.

Once the latches are locked, the latch access panel has to be closed.

Manual Opening/Closing

The fan cowl doors can be opened manually. To open the fan cowl door the maintenance personnel (two mechanics at the same time) must push on the pushing area of the fan cowl door, that is located on the lower leading edge, until both hold open rods are in the fully open and locked position. To close the fan cowl door, the maintenance personnel must unlock de HOR and slowly close it up to the fully closed position.


FAN COWL CLOSED
FWD
L1
L2
L3
L4
FAN COWL LATCHES
PUSHING AREA
FAN COWL CTL SWITCHES
INTERPHONE JACK
RELEASE LEVER
HOLD OPEN ROD (HOR)
LATCH ACCESS DOOR
FAN COWL OPENED

FAN COWL

UNLATCH SEQUENCE: L2, L3, L1 & L4

FROM 0° TO 41° UNLOCKED: RED INDICATOR

FROM INTERMEDIATE POSITION (41°) LOCKED TO 49° UNLOCKED: NO INDICATOR

49° LOCKED: GREEN INDICATOR

MAKE SURE THAT:
- WIND SPEED < 45 Kts,
- SLATS ARE RETRACTED & LOCKED, FOR FULLY OPENING THE FANCOWL

FAN COWL - OPENING ... MANUAL OPENING/CLOSING

ENGINE COWLING DESCRIPTION (2)

Fan Exhaust Cowl/Thrust Reverser Cowl

Opening

The fan exhaust cowl doors can be opened for maintenance functions on the engine. The unlatching sequence is carried out from the latch access door and the latches all installed at the bottom of the fan exhaust cowl. The Unlocking of these latches is done in a defined sequence:
- the latch L1 is opened first by pulling the lock trigger and the handle to the down position,
- the latch L6.2 handle has to be fully open,
- the latch L6.1,

NOTE: A push/pull cable connects the latch L6.2 to the latch L7. When you unlatch the latch L6.2, you unlatch the latch L7 at the same time.

- the latch L5.2,
- the latch L5.1,
- the latch L4,
- the latch L3,
- the latch L2.

Once the fan exhaust cowl doors are unlocked, the opening is done from the opening actuator switch box. There is one switch box per side. The maintenance personnel must push the UP switch until the fan exhaust cowl door is opened and the HOR is locked. When the HOR is locked, the green stripe is visible. Then the maintenance personnel must push the DOWN switch to hold the exhaust cowl on the HOR. The fan exhaust cowl doors have two open positions:
- initial position of 35 degrees,
- full open position of 45 degrees.

NOTE: To open the cowl up to 45 degrees, it must be open up to 35 degrees before and Hold Open Rod has to be put on its 45 degrees fitting.

Human factor points:

CAUTION: - MAKE SURE THAT THE WIND SPEED CONDITIONS ARE NOT MORE THAN 45 KNOTS.
- BEFORE OPENING THE FAN EXHAUST COWLS, MAKE SURE THAT SLATS ARE RETRACTED AND THAT THEY CANNOT MOVE, TO PREVENT FROM POSSIBLE INTERFERENCES.
- BEFORE OPENING THE FAN EXHAUST COWLS OF INBOARD ENGINES (2 OR 3), MAKE SURE THAT THE THRUST REVERSER SYSTEM HAS BEEN DEACTIVATED FOR MAINTENANCE.

Closing

At the end of maintenance tasks on the engine, the fan exhaust cowl doors have to be closed to put the aircraft back into operation. First of all, the maintenance personnel must push the UP switch to unload the HORs. The HOR is then unlocked and in this case, the red stripe is visible. The DOWN switch must be pushed and held until the fan exhaust cowl door closes completely.

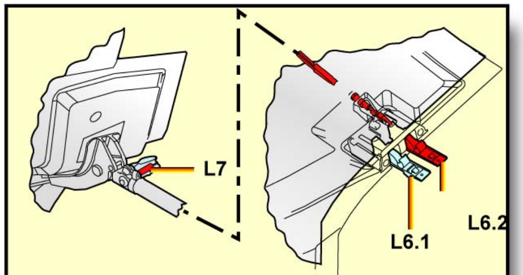
NOTE: You cannot close the cowl from the 45 degrees position to the 35 degrees position directly. At 35 degrees, put the Hold Open Rod on the 35 degrees HOR fitting.

The locking of these latches is done in a defined sequence:
- the latch L2 first,
- the latch L3,
- the latch L4,
- the latch L5.1,
- the latch L5.2,
- the latch L6.1,

NOTE: A push/pull cable connects the latch L6.2 to the latch L7. When you latch the latch L6.2, you latch the latch L7 at the same time.

- the latch L6.2 handle has to be fully closed,
- and at the end, the latch L1 is closed by pulling the lock trigger and the handle upward.

Once the latches are locked, the latch access door has to be closed.



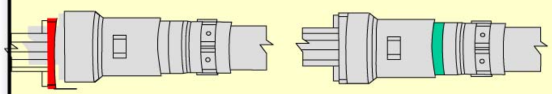
L6.2 AND L7 ARE CONNECTED BY A PUSH/PULL CABLE.

FAN EXHAUST COWL/ THRUST REVERSER COWL

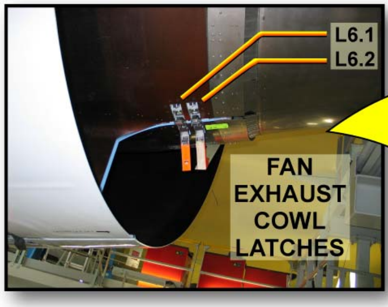
UNLATCH SEQUENCE:
L1, L6.2, L6.1, L5.2, L5.1, L4, L3, AND L2

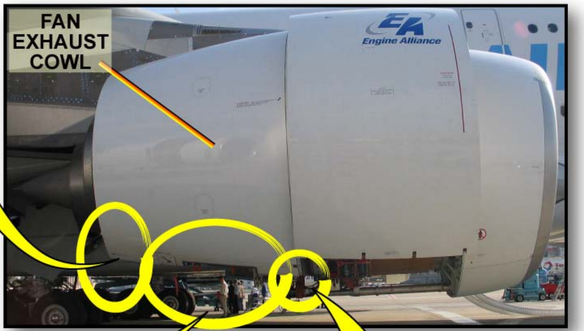
LATCH SEQUENCE:
L2, L3, L4, L5.1, L5.2, L6.1, L6.2, AND L1

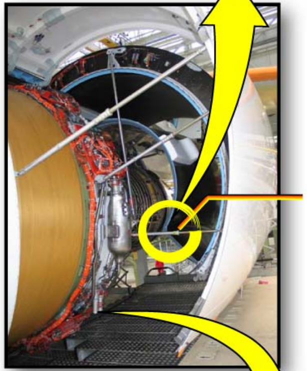
HOLD OPEN ROD



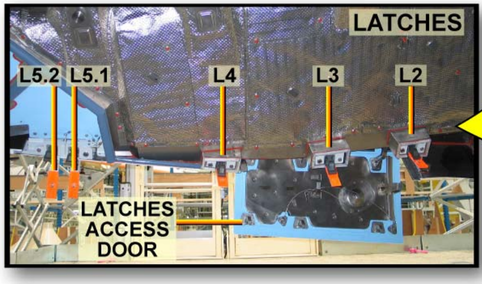
RED VISIBLE: HOR UNLOCKED	GREEN VISIBLE: HOR LOCKED

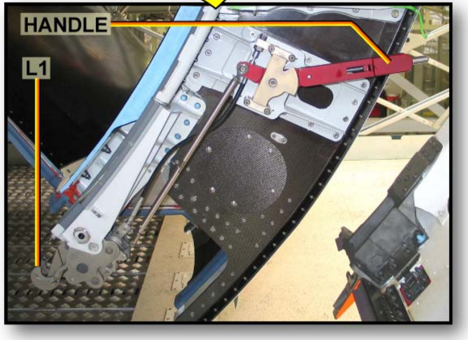

L6.1
L6.2
FAN EXHAUST COWL LATCHES

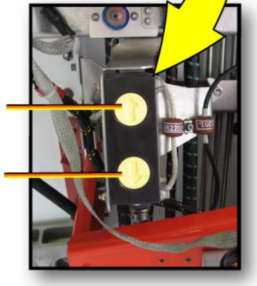

FAN EXHAUST COWL
EA Engine Alliance


HOLD OPEN ROD

FAN EXHAUST COWL OPENED


LATCHES
L5.2
L5.1
L4
L3
L2
LATCHES ACCESS DOOR




UP SWITCH
DOWN SWITCH

FAN EXHAUST COWL OPENING COMMAND SWITCH BOX

MAKE SURE THAT:
- **WIND SPEED < 45 Kts,**
- **SLATS ARE RETRACTED & LOCKED,**
- **T/R SYSTEM IS DEACTIVATED (ENG 2 & 3),**

FOR OPENNIG OF THE FAN EXHAUST COWL / THRUST REVERSER COWL

FAN EXHAUST COWL/THRUST REVERSER COWL - OPENING & CLOSING

LB408521 - L5CT0T0 - LM7EDTLEVEL0201

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ENGINE COWLING DESCRIPTION (2)

Fan Exhaust Cowl/Thrust Reverser Cowl (continued)

Manual Opening/Closing

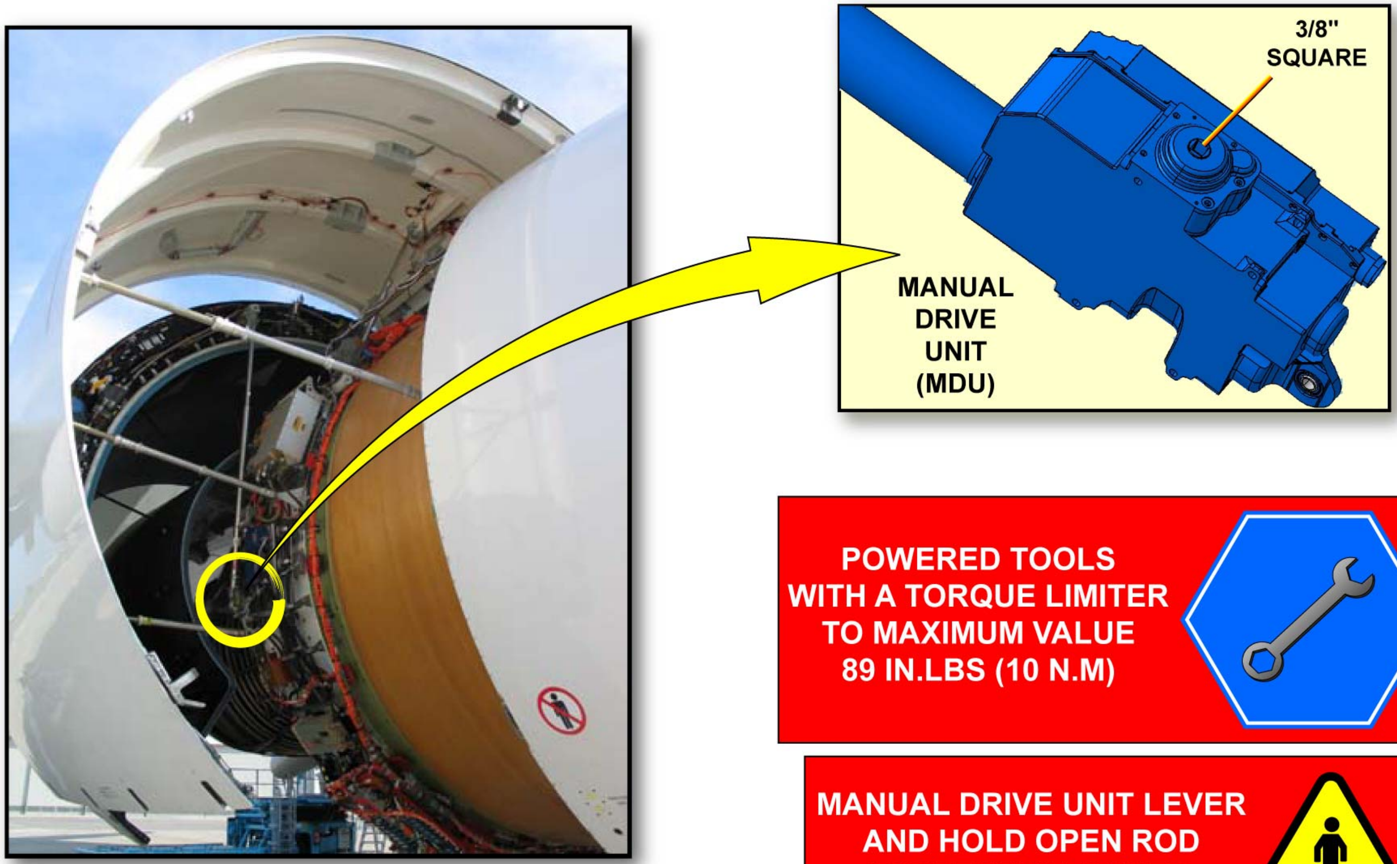
Each fan exhaust cowl/thrust reverser cowl has an opening actuator with Manual Drive Unit (MDU). This MDU can be used for the opening/closing of the fan exhaust cowl/thrust reverser cowl when the electrical power is off, or in case of failure of the electrical functions in the cowl opening system. The fan exhaust cowl/thrust reverser cowl can be open manually to 35 or 45 degrees.
To open the fan exhaust cowl/thrust reverser cowl manually, you must:
- turn the MDU to the opened position,
- install the torque wrench 3/8 inches in the opening actuator,
- turn the torque wrench clockwise to open the fan exhaust cowl/thrust reverser cowl to the 35 degrees position. You must stop turning when the HOR is on the locked position.

NOTE: The HOR makes a rattling noise at the locked position.
- remove the manual wrench when the HOR rod is locked and turn the MDU lever in the full closed position in order to release the load directly on the HOR.
- turn the MDU lever in the open position again and insert the red flag.

NOTE: The HOR locking sleeve must slide to show the green stripe (locked position) and hide the red stripe.
Human factor points:

WARNING: LOCK THE MANUAL DRIVE UNIT LEVER AND BE SURE THE HOLD OPEN ROD IS CORRECTLY LOCKED BEFORE DOING ANY MAINTENANCE OPERATION UNDER THE FAN EXHAUST COWL OR THRUST REVERSER COWL.

CAUTION: - IF POWERED TOOLS ARE USED, ONLY USE POWERED TOOLS WITH A TORQUE LIMITER TO MAXIMUM VALUE 89 IN.LBS (10 N.M).
- TURN THE TORQUE WRENCH SLOWLY WHEN THE HOLD OPEN ROD IS NEAR THE LOCKED POSITION TO PREVENT DAMAGE TO THE HOLD OPEN ROD AND TO THE THRUST REVERSER STRUCTURE.



OPENING ACTUATOR

POWERED TOOLS WITH A TORQUE LIMITER TO MAXIMUM VALUE 89 IN.LBS (10 N.M)

MANUAL DRIVE UNIT LEVER AND HOLD OPEN ROD CORRECTLY LOCKED

OPENING SPEED WHEN THE HOLD OPEN ROD NEAR THE LOCKED POSITION

FAN EXHAUST COWL/THRUST REVERSER COWL - MANUAL OPENING/CLOSING

BASIC ENGINE DESCRIPTION (EA) (3)

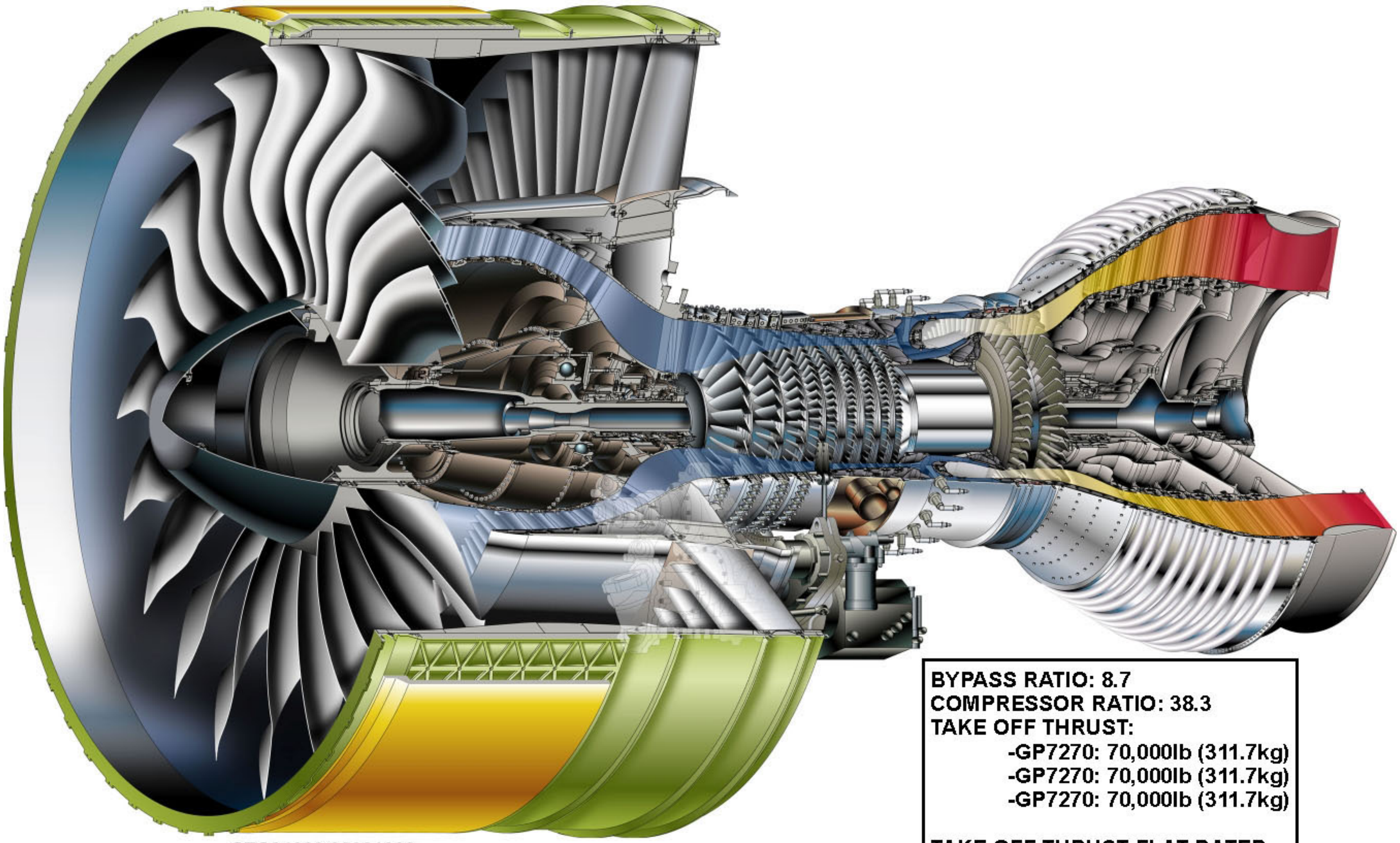
Overview

General

High bypass, two-rotor, axial flow turbofan:
- Bypass ratio - 8.7,
- Compressor pressure ratio - 38.3.

Take off thrust:
- GP7270 - 70,000 lb (311.17 kN),
- GP7277 - 76500 lb (340.07 kN),

NOTE: Note: Take off thrust is flat rated at ISA+15°C (86°F).



BYPASS RATIO: 8.7
COMPRESSOR RATIO: 38.3
TAKE OFF THRUST:
-GP7270: 70,000lb (311.7kg)
-GP7270: 70,000lb (311.7kg)
-GP7270: 70,000lb (311.7kg)

TAKE OFF THRUST FLAT RATED AT I.S.A. +15° (86°F).

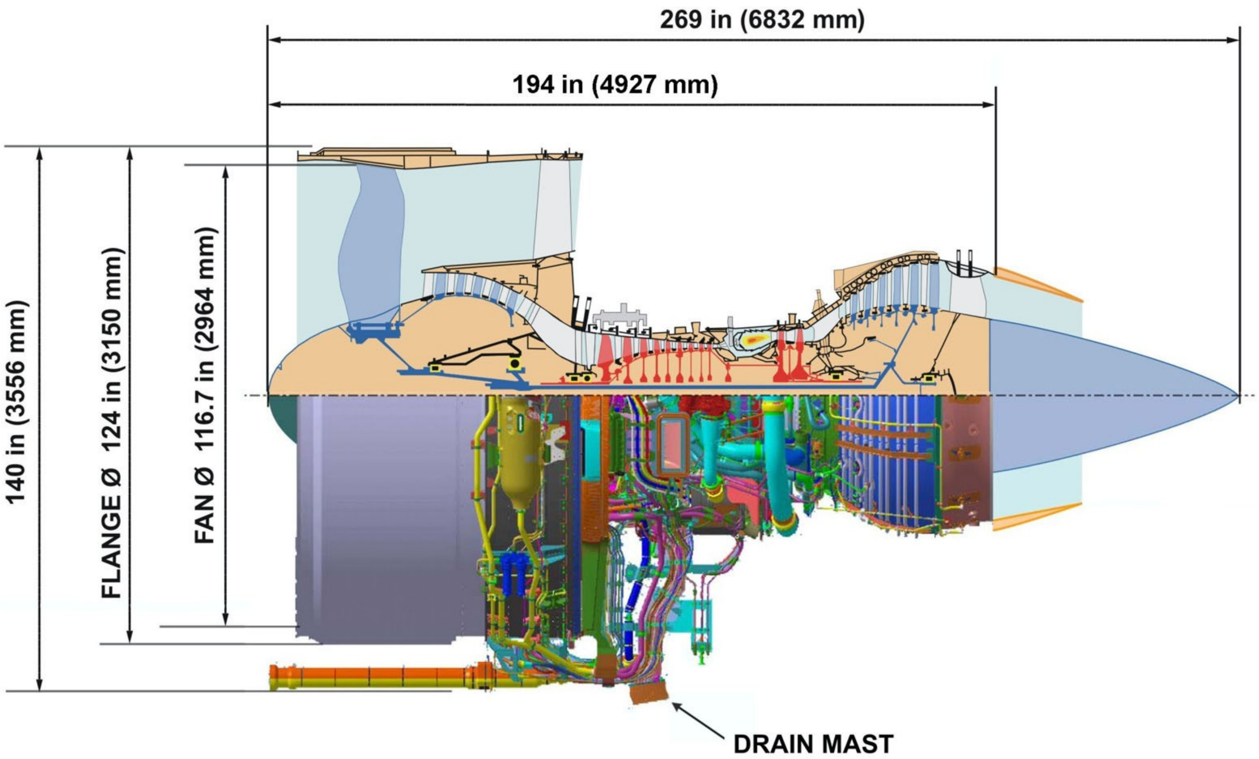
OVERVIEW - GENERAL

BASIC ENGINE DESCRIPTION (EA) (3)

Overview (continued)

Typical Dimensions & Weights

Envelope Diameter - 140.0 in (3556 mm),
Inlet Diameter - 124.0 in (3150 mm),
Fan Diameter - 116.7 in (2946 mm),
Engine Length - 269 in (6832 mm),
Weight:
- Engine - 13,500 lb (6,123 kg),
- Engine with QEC, intake cowl, exhaust nozzle and plug - 15,995 lb (7,225 kg),


269 in (6832 mm)
194 in (4927 mm)
140 in (3556 mm)
FLANGE Ø 124 in (3150 mm)
FAN Ø 116.7 in (2964 mm)
DRAIN MAST

CTC70042.20061108

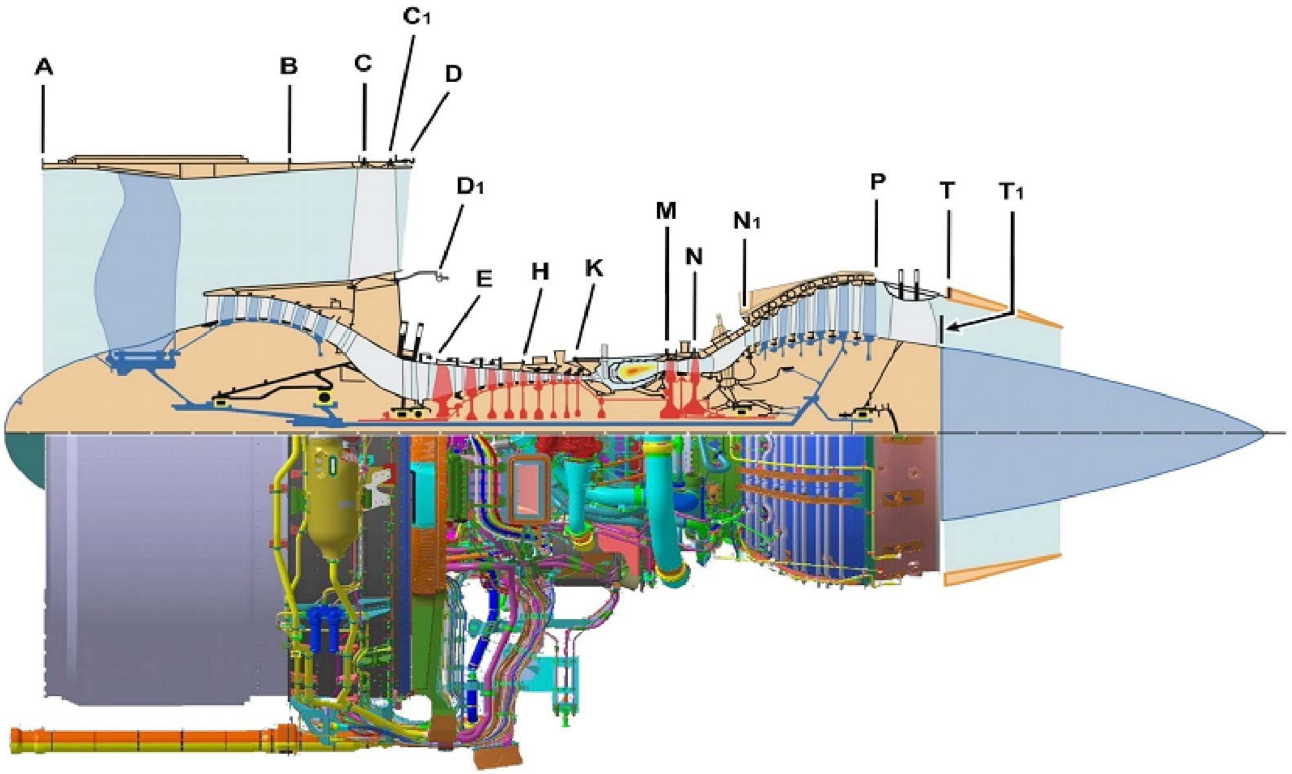
OVERVIEW - TYPICAL DIMENSIONS & WEIGHTS

BASIC ENGINE DESCRIPTION (EA) (3)

Construction Features

Engine Flanges

A - Inlet Cowl Attachment,
B - Front Fan Case to the Aft Fan Case,
C - Fan Exit Outer Case to Fan Hub Frame,
C1 - Stiffness and Bracket Attachment,
D - "V" Ring Groove,
D1 - "V" Ring Groove,
E - Fan Hub Frame to HPC Front Case,
H - HPC Front Case to HPC Rear Case,
K - HPC Rear Case to Combustion Case,
M - Combustion Case to HPT Case,
N - HPT Case to Turbine Center Frame,
N1 - Turbine Center Frame to LPT Case,
P - LPT Case to Turbine Exhaust Case,
T - Turbine Exhaust Nozzle Attachment,
T1 - Turbine Exhaust Plug Attachment.


C1
A
B
C
D
D1
E
H
K
M
N
N1
P
T
T1
CTC70043.20060713

CONSTRUCTION FEATURES - ENGINE FLANGES

BASIC ENGINE DESCRIPTION (EA) (3)

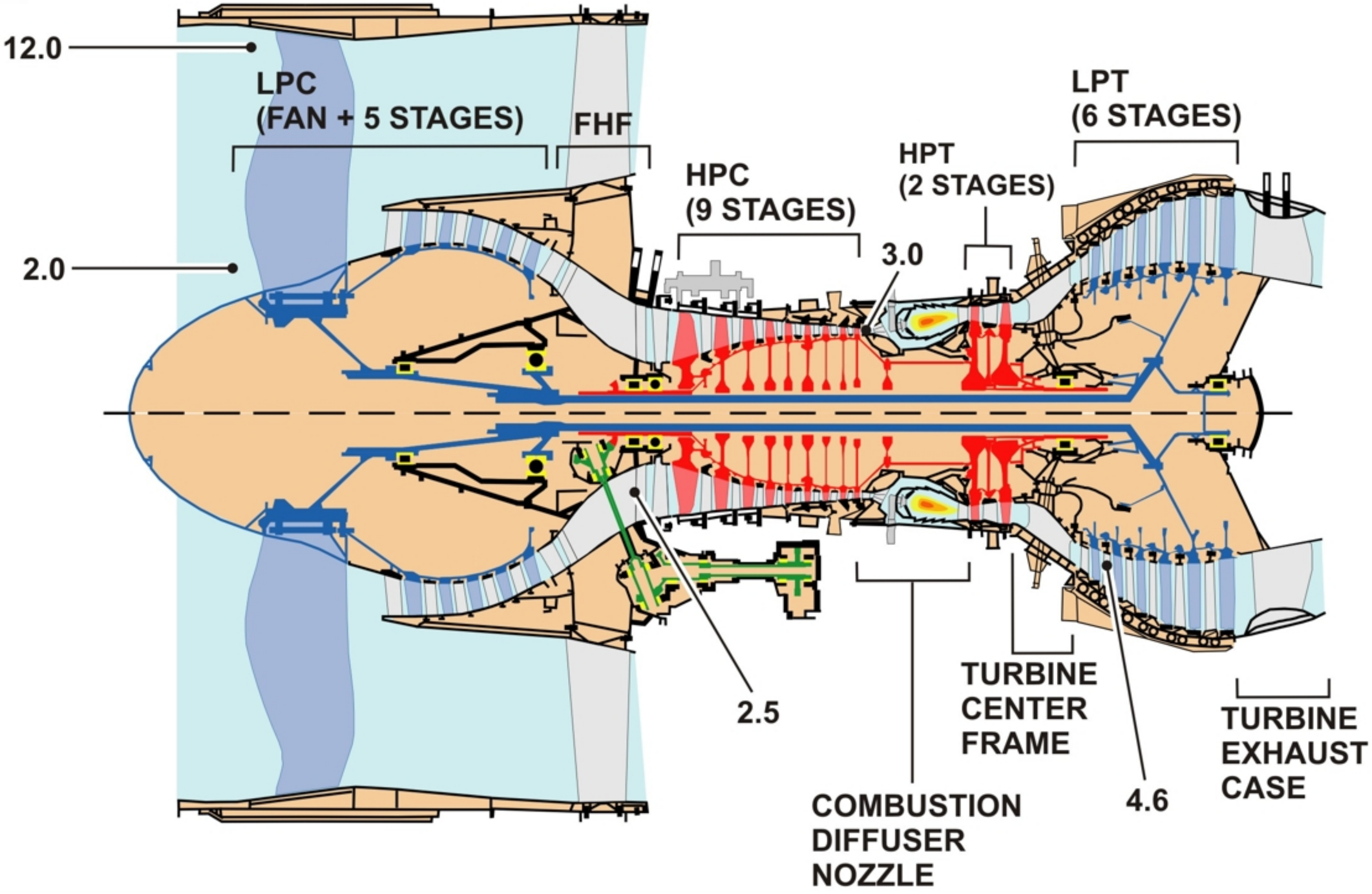
Construction Features (continued)

Gaspath Configuration

Low Pressure Compressor (LPC),
Fan Hub Frame (FHF),
High Pressure Compressor (HPC),
Combustion Diffuser Nozzle,
High Pressure Turbine (HPT),
Turbine Center Frame (TCF),
Low Pressure Turbine (LPT),
Turbine Exhaust Case (TEC).

Gaspath Stations

2.0 - Engine Core Inlet,
2.5 - HPC inlet,
3.0 - HPC Exit,
4.6 - LPT 2nd Stage Vanes,
12.0 - Fan Inlet.


12.0
2.0
LPC
(FAN + 5 STAGES)
FHF
HPC
(9 STAGES)
HPT
(2 STAGES)
3.0
LPT
(6 STAGES)
2.5
COMBUSTION
DIFFUSER
NOZZLE
TURBINE
CENTER
FRAME
4.6
TURBINE
EXHAUST
CASE

CTC70045.20061120

CONSTRUCTION FEATURES - GASPATH CONFIGURATION & GASPATH STATIONS

BASIC ENGINE DESCRIPTION (EA) (3)

Construction Features (continued)

Engine Main Bearings

No. 1 Roller Bearing:
- Gives radial support to the front of the low speed rotor,
- Supported by the fan hub frame.

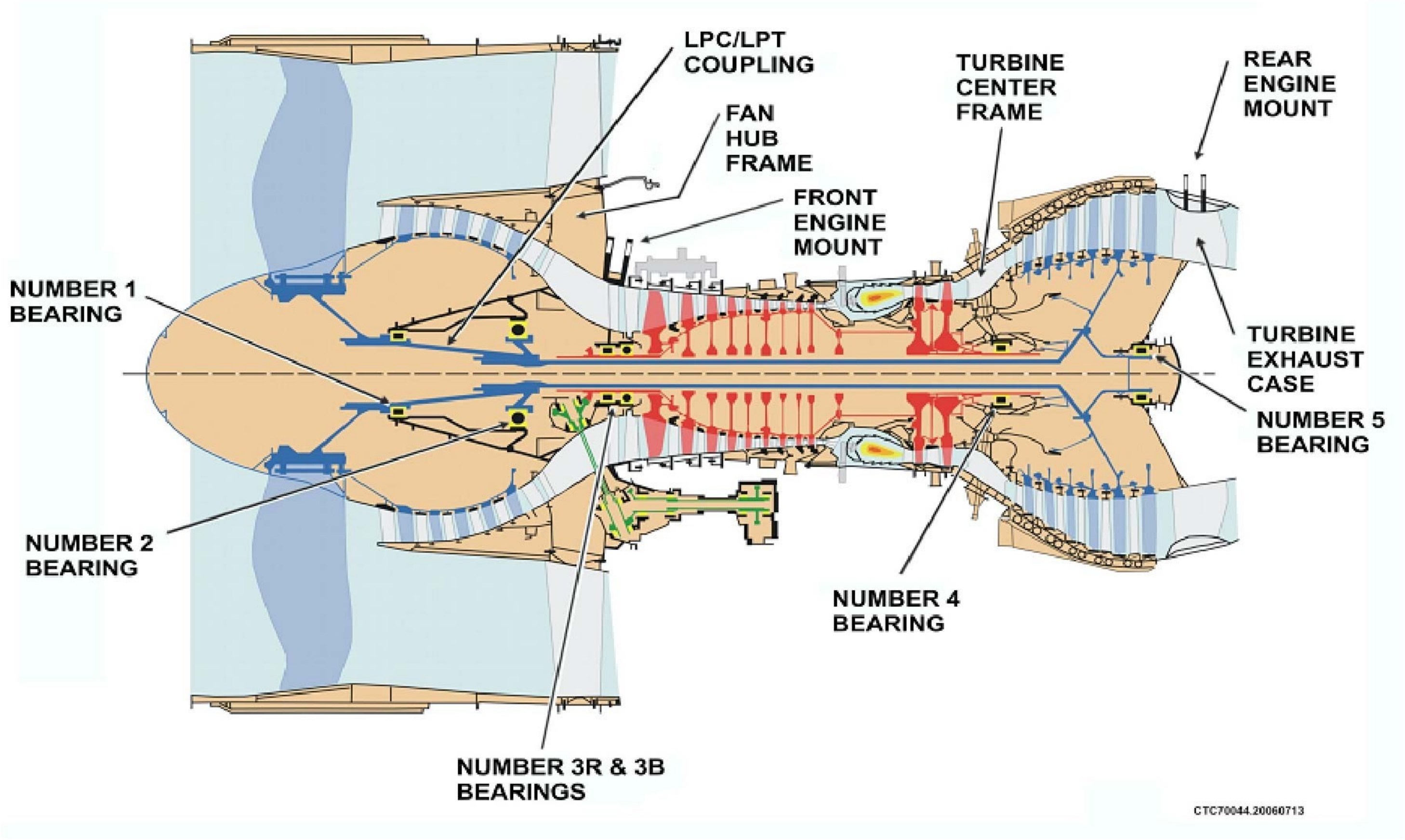
No. 2 Ball Bearing:
- Gives radial and axial support to the low speed rotor,
- Supported by the fan hub frame.

No. 3 Roller Bearing:
- Gives radial support to the front of the high speed rotor,
- Oil damped.

No. 3 Ball Bearing:
- Gives axial and radial support to the front of the high speed rotor,
- Supported by the fan hub frame.

No. 4 Roller Bearing:
- Gives radial support to the rear of the high speed rotor,
- Supported by the turbine center frame.
- Oil damped.

No. 5 Roller Bearing:
- Gives radial support to the rear of the low speed rotor,
- Supported by the turbine exhaust case,
- Oil damped.


LPC/LPT
COUPLING
TURBINE
CENTER
FRAME
REAR
ENGINE
MOUNT
FAN
HUB
FRAME
FRONT
ENGINE
MOUNT
NUMBER 1
BEARING
TURBINE
EXHAUST
CASE
NUMBER 5
BEARING
NUMBER 2
BEARING
NUMBER 4
BEARING
NUMBER 3R & 3B
BEARINGS
CTC70044.20060713

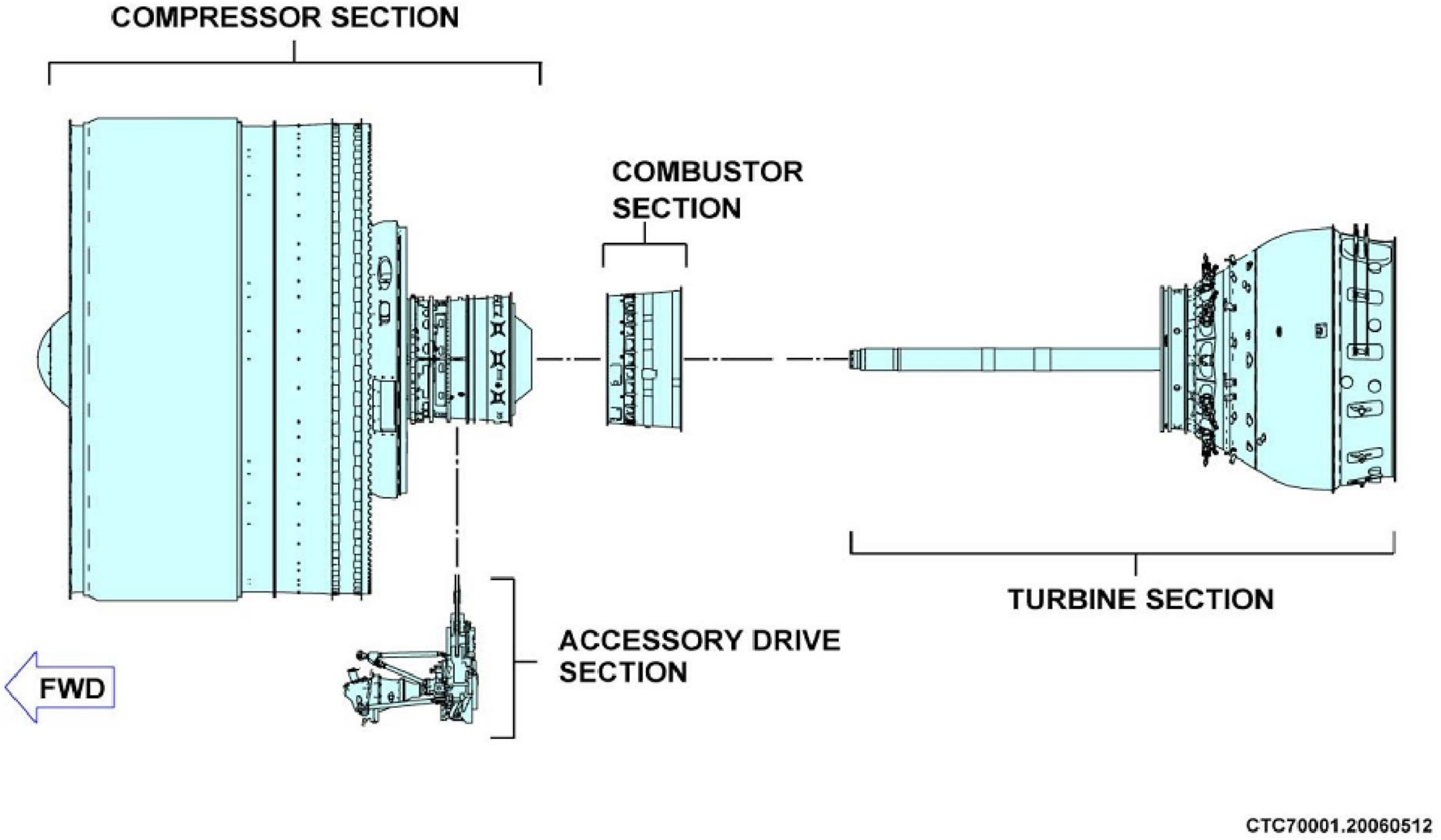
CONSTRUCTION FEATURES - ENGINE MAIN BEARINGS

BASIC ENGINE DESCRIPTION (EA) (3)

Construction Features (continued)

Engine Sections

Compressor,
Combustor,
Turbine,
Accessory Drive.


COMPRESSOR SECTION
COMBUSTOR SECTION
TURBINE SECTION
ACCESSORY DRIVE SECTION
FWD
CTC70001.20060512

CONSTRUCTION FEATURES - ENGINE SECTIONS

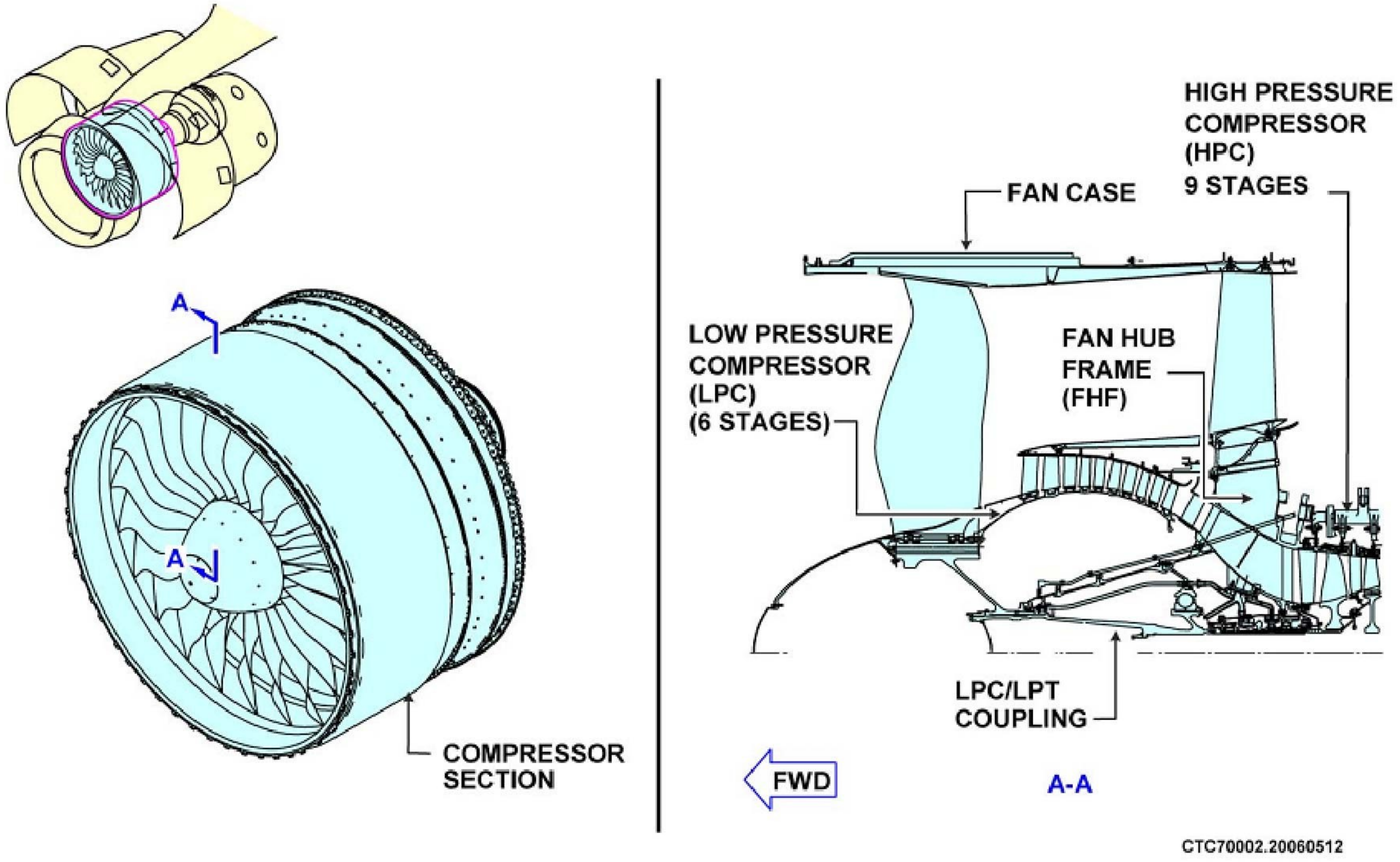
BASIC ENGINE DESCRIPTION (EA) (3)

Compressor Section

Compressor Section - General

Purpose:
- Supplies high pressure compressed air to the combustor diffuser for core engine thrust, aircraft service bleed systems and bypass air for thrust.

Components:
- Low Pressure Compressor (LPC),
- LPC/LPT coupling and bearing support,
- Fan cases,
- Fan Hub Frame (FHF),
- High Pressure Compressor (HPC).


A
A
COMPRESSOR
SECTION
HIGH PRESSURE
COMPRESSOR
(HPC)
9 STAGES
FAN CASE
LOW PRESSURE
COMPRESSOR
(LPC)
(6 STAGES)
FAN HUB
FRAME
(FHF)
LPC/LPT
COUPLING
FWD
A-A
CTC70002.20060512

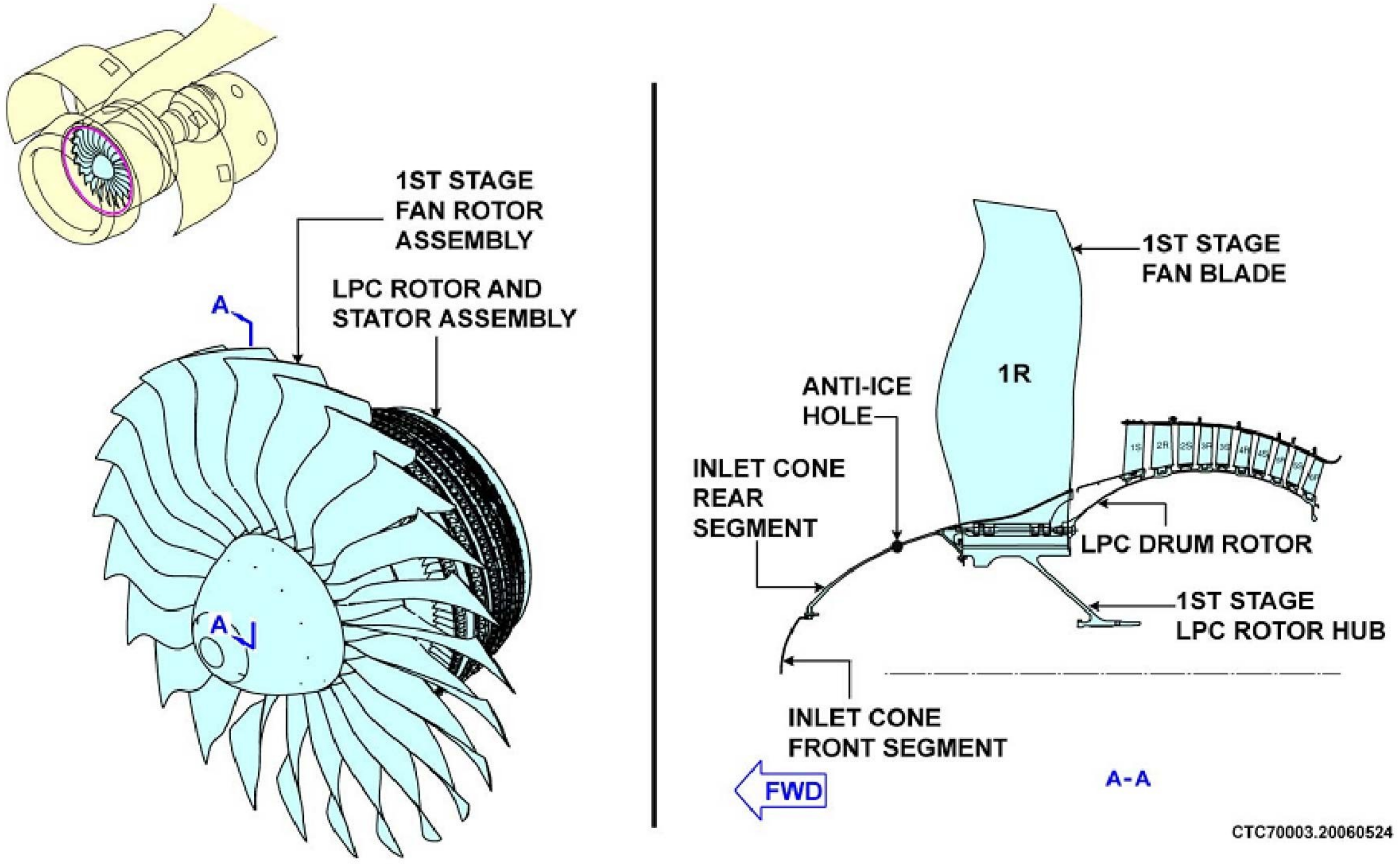
COMPRESSOR SECTION - COMPRESSOR SECTION - GENERAL

BASIC ENGINE DESCRIPTION (EA) (3)

Compressor Section (continued)

Low Pressure Compressor

Purpose:
- Provides compressed air for the primary engine gaspath, and fan bypass air for propulsion.
Description:
- Supports the two piece inlet cone:
. The inlet cone rear segment has anti-ice air vent holes.
- 6 stage rotor:
. 1 fan and 5 primary stages,
. 5 stator assemblies.


1ST STAGE FAN ROTOR ASSEMBLY
LPC ROTOR AND STATOR ASSEMBLY
A
A
1ST STAGE FAN BLADE
1R
ANTI-ICE HOLE
INLET CONE REAR SEGMENT
LPC DRUM ROTOR
1ST STAGE LPC ROTOR HUB
INLET CONE FRONT SEGMENT
FWD
A-A
CTC70003.20060524

COMPRESSOR SECTION - LOW PRESSURE COMPRESSOR

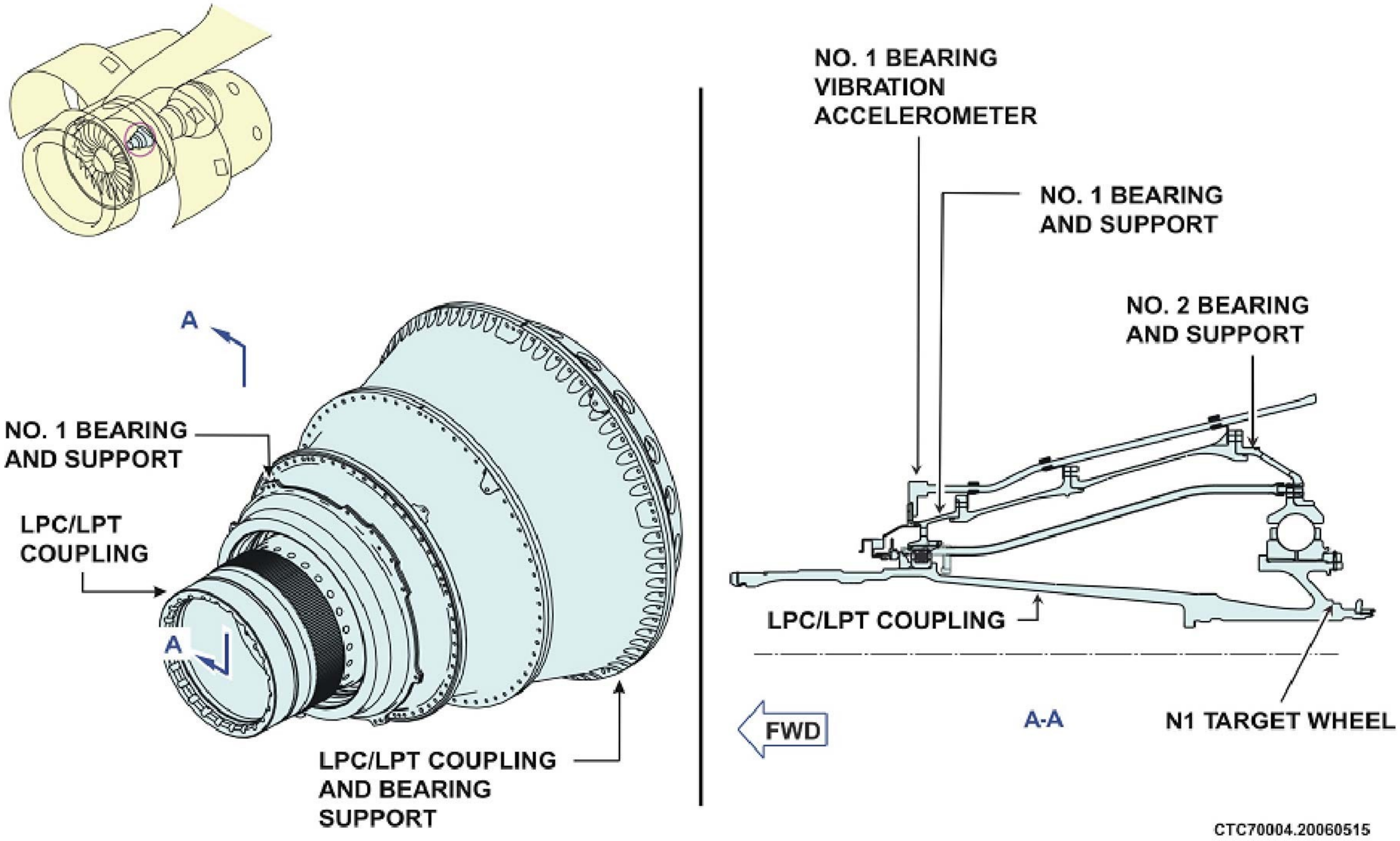
BASIC ENGINE DESCRIPTION (EA) (3)

Compressor Section (continued)

LPC/LPT Coupling & Bearing Support

Purpose:
- Supports and controls the axial and radial position of the low speed rotor,
- Transfers the rotational power from the LPT shaft to the LPC rotor.

Description:
- Contains the No. 1 and 2 bearings,
- Has a N1 target wheel for low rotor (N1) speed determination,
- The No. 1 bearing vibration accelerometer is attached to the bearing support.


NO. 1 BEARING AND SUPPORT
LPC/LPT COUPLING
A
A
LPC/LPT COUPLING AND BEARING SUPPORT
NO. 1 BEARING VIBRATION ACCELEROMETER
NO. 1 BEARING AND SUPPORT
NO. 2 BEARING AND SUPPORT
LPC/LPT COUPLING
FWD
A-A
N1 TARGET WHEEL
CTC70004.20060515

COMPRESSOR SECTION - LPC/LPT COUPLING & BEARING SUPPORT

BASIC ENGINE DESCRIPTION (EA) (3)

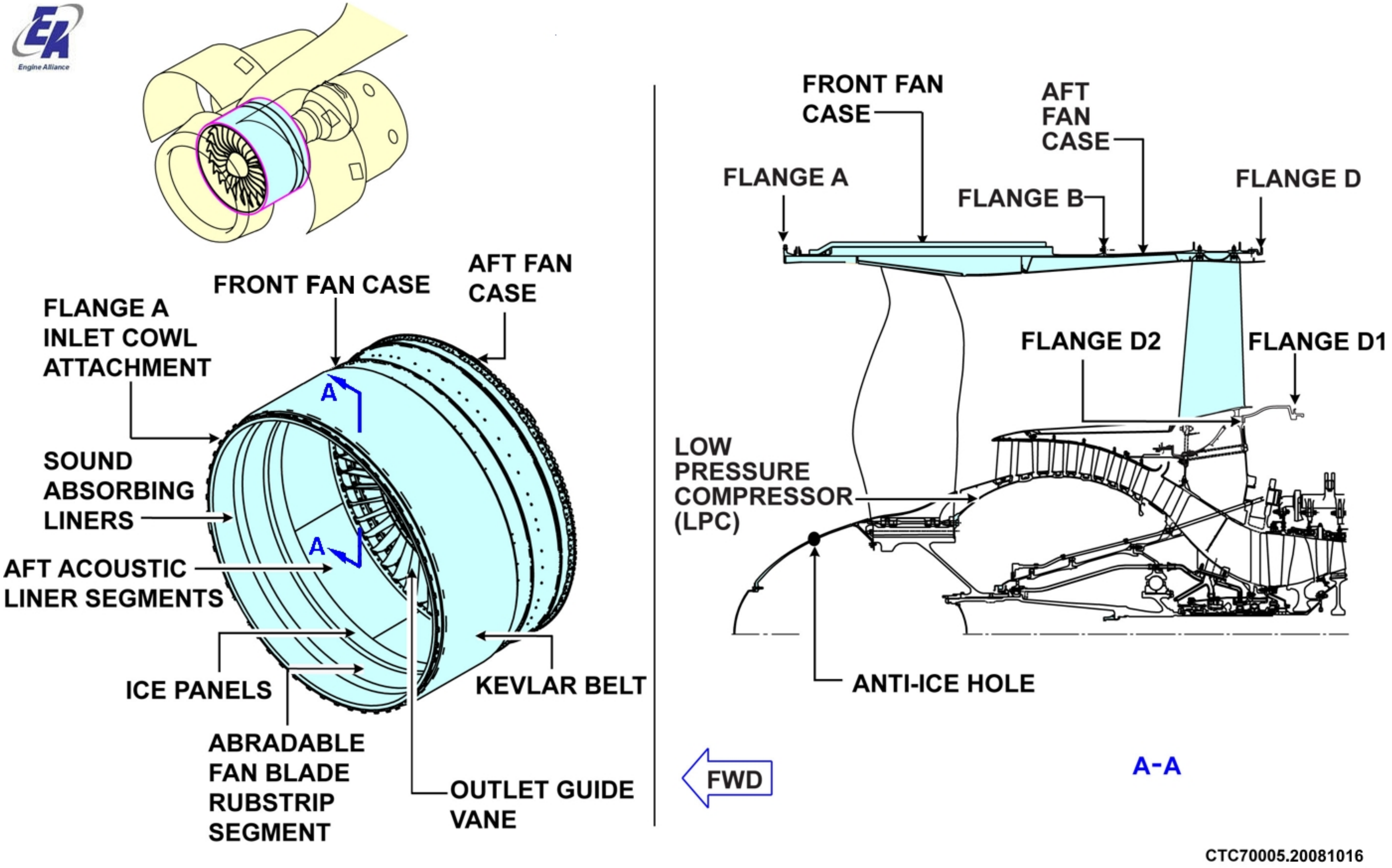
Compressor Section (continued)

Fan Case

Purpose:
- Provide structural link between the inlet cowl and the core of the engine.

Front fan case:
- Supports the inlet cowl,
- Kevlar belt,
- Contains:
  . Sound absorbing liners,
  . Acoustic liner segments,
  . Ice panels,
  . Fan blade rubstrip segments.

Aft fan case:
- Supports the front fan case,
- Contains the 56 outlet guide vanes (OGVs).


Engine Alliance
FRONT FAN CASE
AFT FAN CASE
FLANGE A INLET COWL ATTACHMENT
A
SOUND ABSORBING LINERS
A
AFT ACOUSTIC LINER SEGMENTS
ICE PANELS
KEVLAR BELT
ABRADABLE FAN BLADE RUBSTRIP SEGMENT
OUTLET GUIDE VANE
FRONT FAN CASE
AFT FAN CASE
FLANGE A
FLANGE B
FLANGE D
FLANGE D2
FLANGE D1
LOW PRESSURE COMPRESSOR (LPC)
ANTI-ICE HOLE
FWD
A-A
CTC70005.20081016

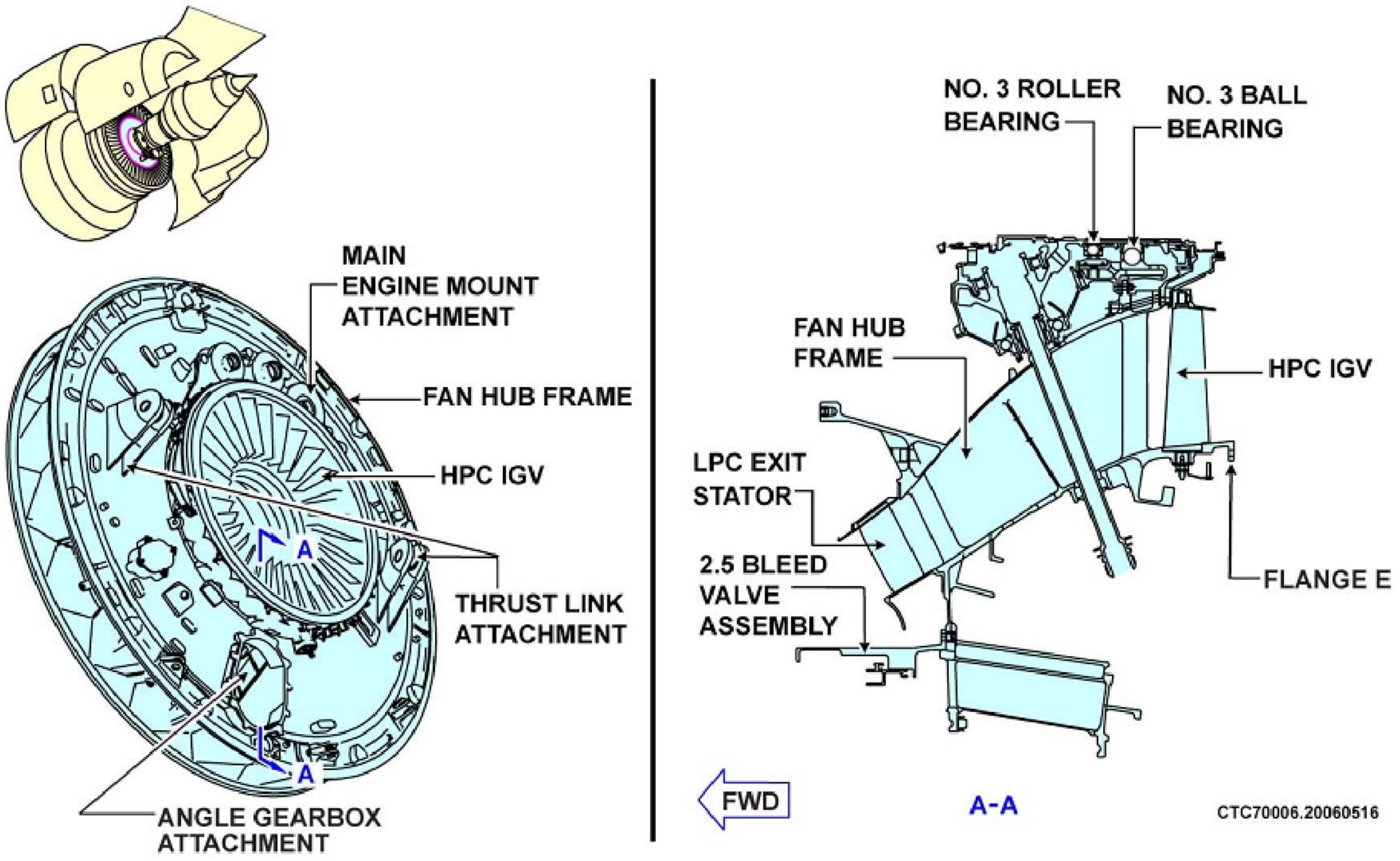
COMPRESSOR SECTION - FAN CASE

BASIC ENGINE DESCRIPTION (EA) (3)

Compressor Section (continued)

Fan Hub Frame

Purpose:
- Provides major structural support of the engine.
Description:
- Supports:
. No. 1, No. 2, and No. 3 bearings,
. 2.5 bleed valve,
. Angle gearbox.
- Attachment for:
. LPC exit stator,
. HPC inlet variable guide vanes,
. Front engine mount:
* Main mount at 12 o'clock,
* Thrust links at 9 o'clock and 3 o'clock.


MAIN
ENGINE MOUNT
ATTACHMENT
FAN HUB FRAME
HPC IGV
A
THRUST LINK
ATTACHMENT
A
ANGLE GEARBOX
ATTACHMENT
NO. 3 ROLLER
BEARING
NO. 3 BALL
BEARING
FAN HUB
FRAME
HPC IGV
LPC EXIT
STATOR
2.5 BLEED
VALVE
ASSEMBLY
FLANGE E
FWD
A-A
CTC70006.20060516

COMPRESSOR SECTION - FAN HUB FRAME

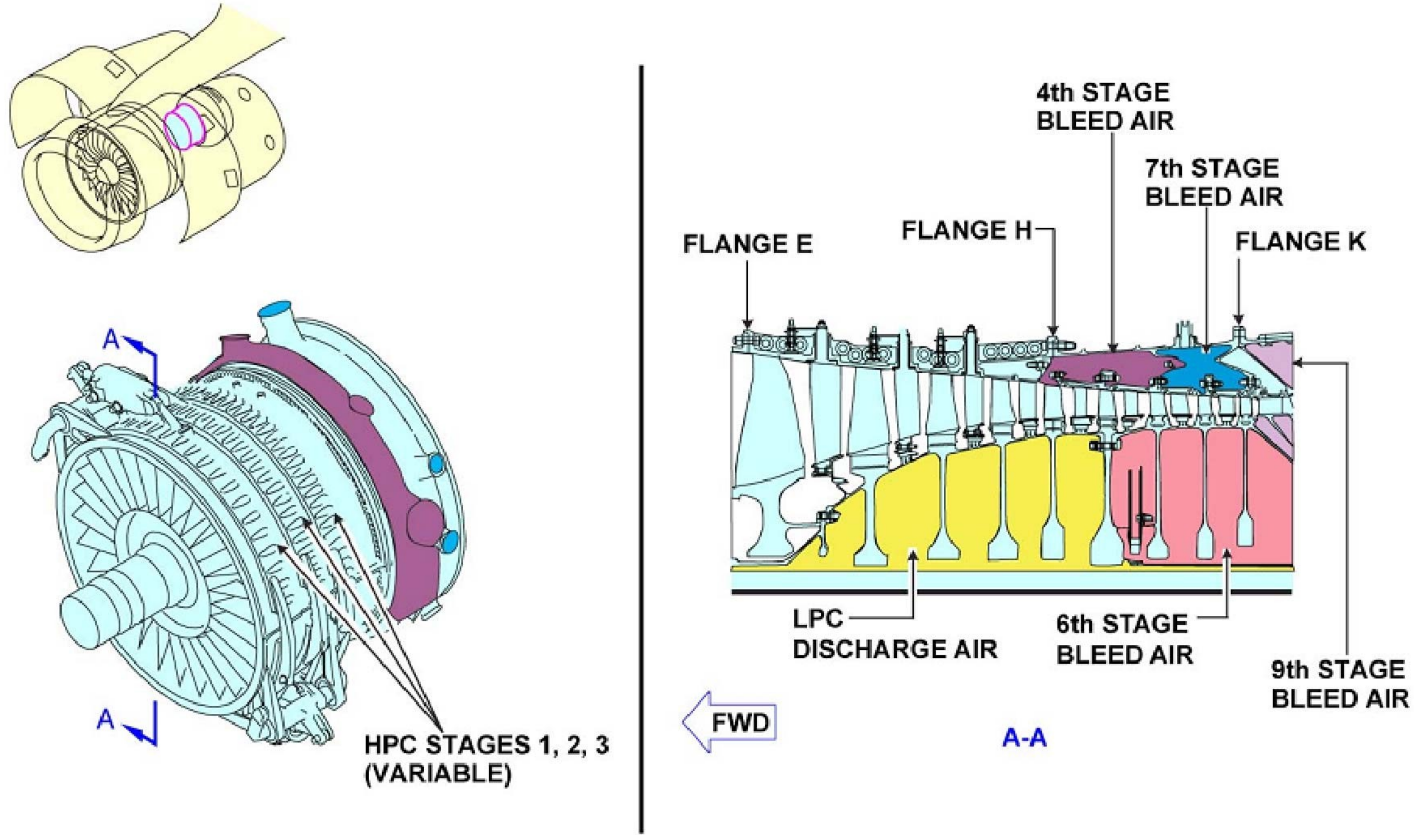
BASIC ENGINE DESCRIPTION (EA) (3)

Compressor Section (continued)

High Pressure Compressor

Purpose:
- Contain, compress, and control the air from the LPC, and send it to the Combustor Diffuser Nozzle (CDN),
- Supply bleed air for aircraft and engine systems use,
- Supply torque to the accessory drive system through the drive gear mounted on the HPC front hub.

Description:
- 9 stage rotor,
- 1st, 2nd, and 3rd HPC stage vanes are variable,
- 4th , 7th, and 9th stage air bleed ports (service bleed air),
- 6th stage air bleed port for secondary engine cooling,
- All vane stages have borescope inspection ports.


A
A
HPC STAGES 1, 2, 3
(VARIABLE)
4th STAGE
BLEED AIR
7th STAGE
BLEED AIR
FLANGE E
FLANGE H
FLANGE K
LPC
DISCHARGE AIR
6th STAGE
BLEED AIR
9th STAGE
BLEED AIR
FWD
A-A

CTC70007.20060516

COMPRESSOR SECTION - HIGH PRESSURE COMPRESSOR

BASIC ENGINE DESCRIPTION (EA) (3)

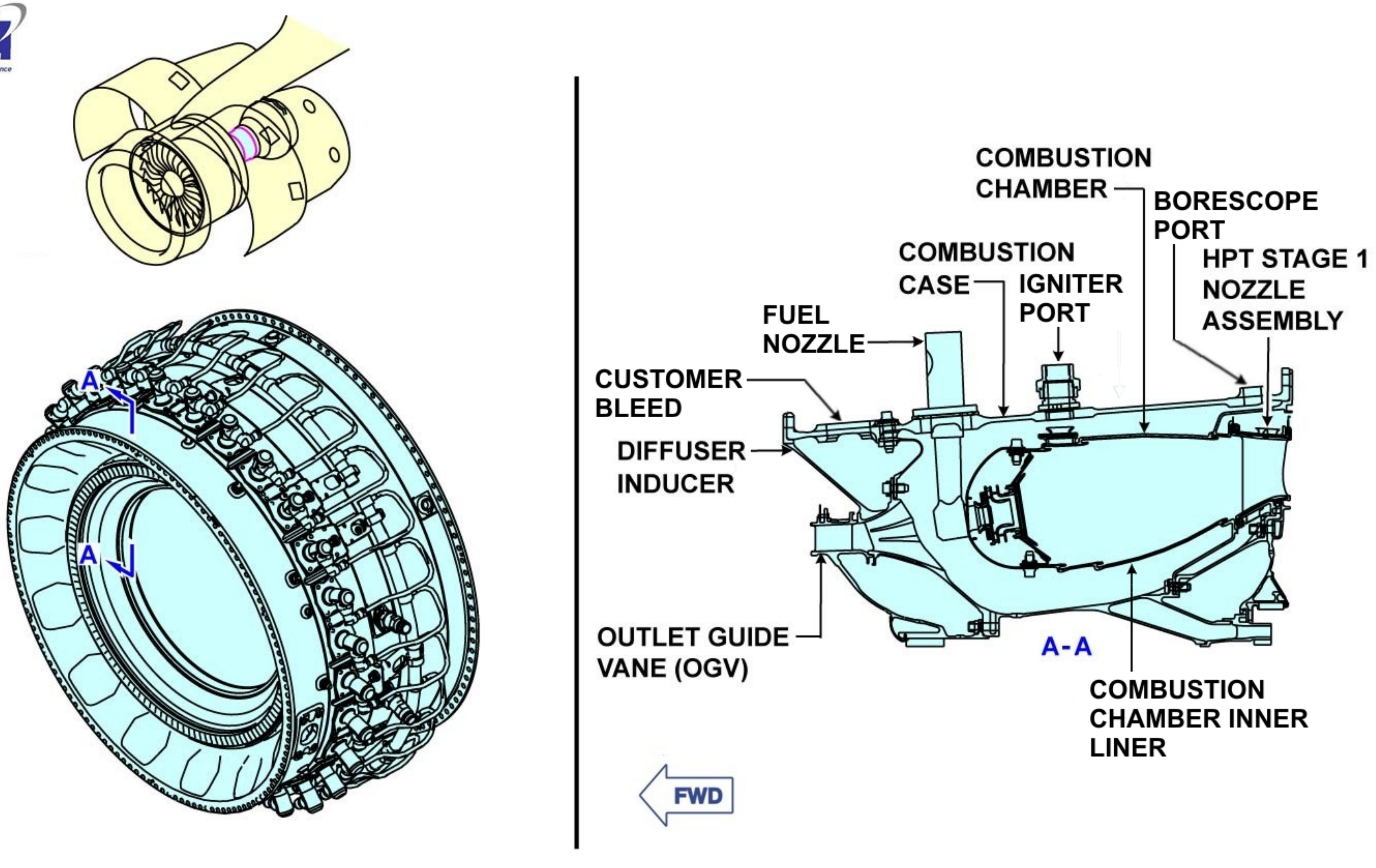
Combustor Section

Combustion Section - General

Purpose:
- Mixes the air with fuel and controls the combustion process,
- Supplies customer bleed air when the engine is at idle power,
- Supports the 9th stage Outlet Guide Vanes (OGVs).
- Supplies cooling air to the High Pressure Turbine Stage 1 nozzle assembly and rotor blades
- Directs the air leaving the combustion chamber to the HPT

Components:
- Combustor diffuser assembly,
- HPC Stage 9 outlet guide vanes
- Diffuser inducer
- Combustion case

o Annular inner and outer liners
o 28 fuel nozzles
o 2 igniter plugs
o 4 borescope ports
o 2 aircraft service bleed bosses


A
A
COMBUSTION CHAMBER
BORESCOPE PORT
COMBUSTION CASE
IGNITER PORT
HPT STAGE 1 NOZZLE ASSEMBLY
FUEL NOZZLE
CUSTOMER BLEED
DIFFUSER INDUCER
OUTLET GUIDE VANE (OGV)
A-A
COMBUSTION CHAMBER INNER LINER
FWD

CTC70008.20081016

COMBUSTOR SECTION - COMBUSTION SECTION - GENERAL

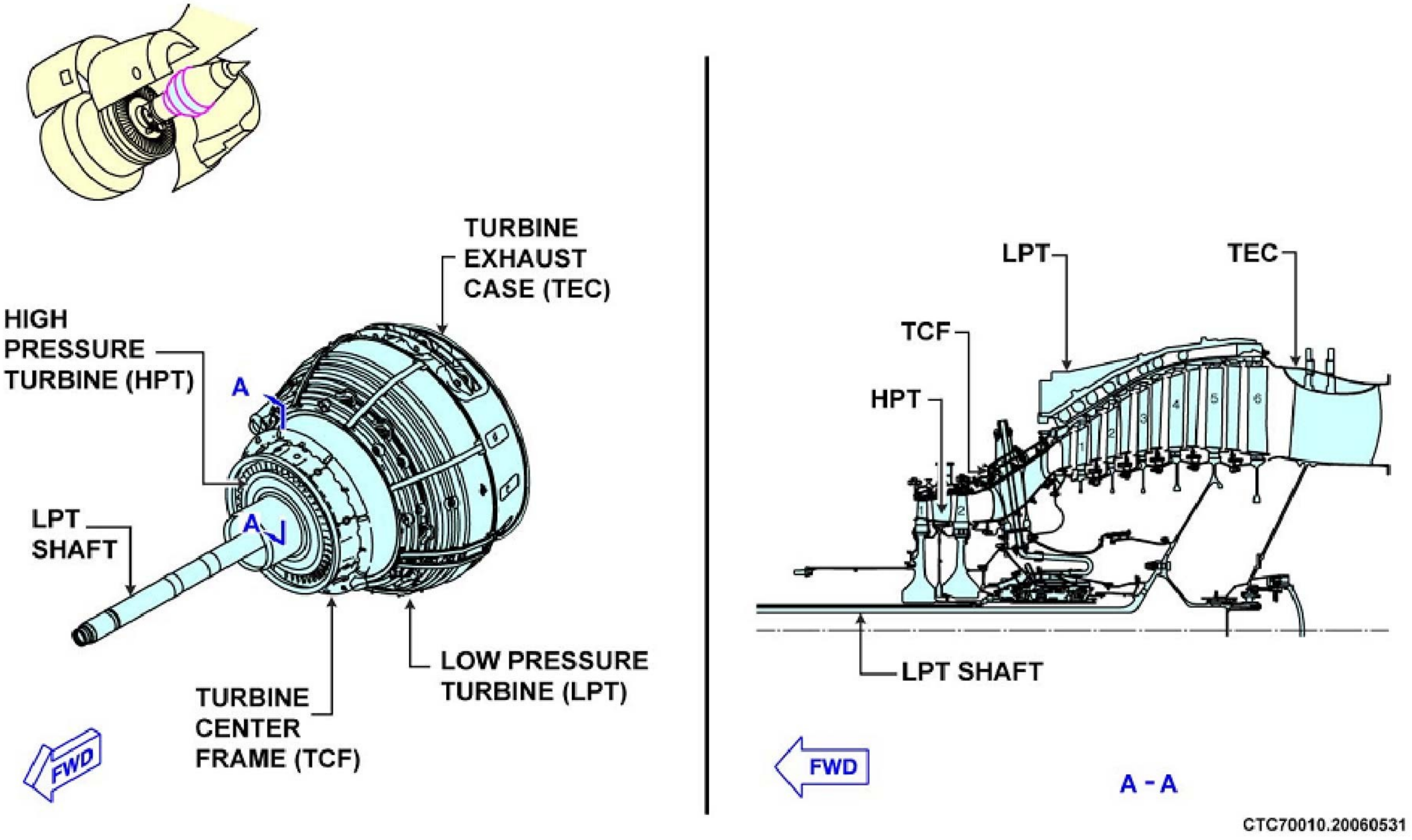
BASIC ENGINE DESCRIPTION (EA) (3)

Turbine Section

Turbine Section - General

Purpose:
- Changes the hot flow path gas energy into torque to operate the rotor assemblies, and the accessory drive section.

Components:
- High pressure turbine,
- Turbine center frame,
- Low pressure turbine,
- Turbine exhaust case.


TURBINE EXHAUST CASE (TEC)
HIGH PRESSURE TURBINE (HPT)
A
LPT SHAFT
A
LOW PRESSURE TURBINE (LPT)
TURBINE CENTER FRAME (TCF)
FWD
LPT
TEC
TCF
HPT
LPT SHAFT
FWD
A - A
CTC70010.20060531

TURBINE SECTION - TURBINE SECTION - GENERAL

BASIC ENGINE DESCRIPTION (EA) (3)

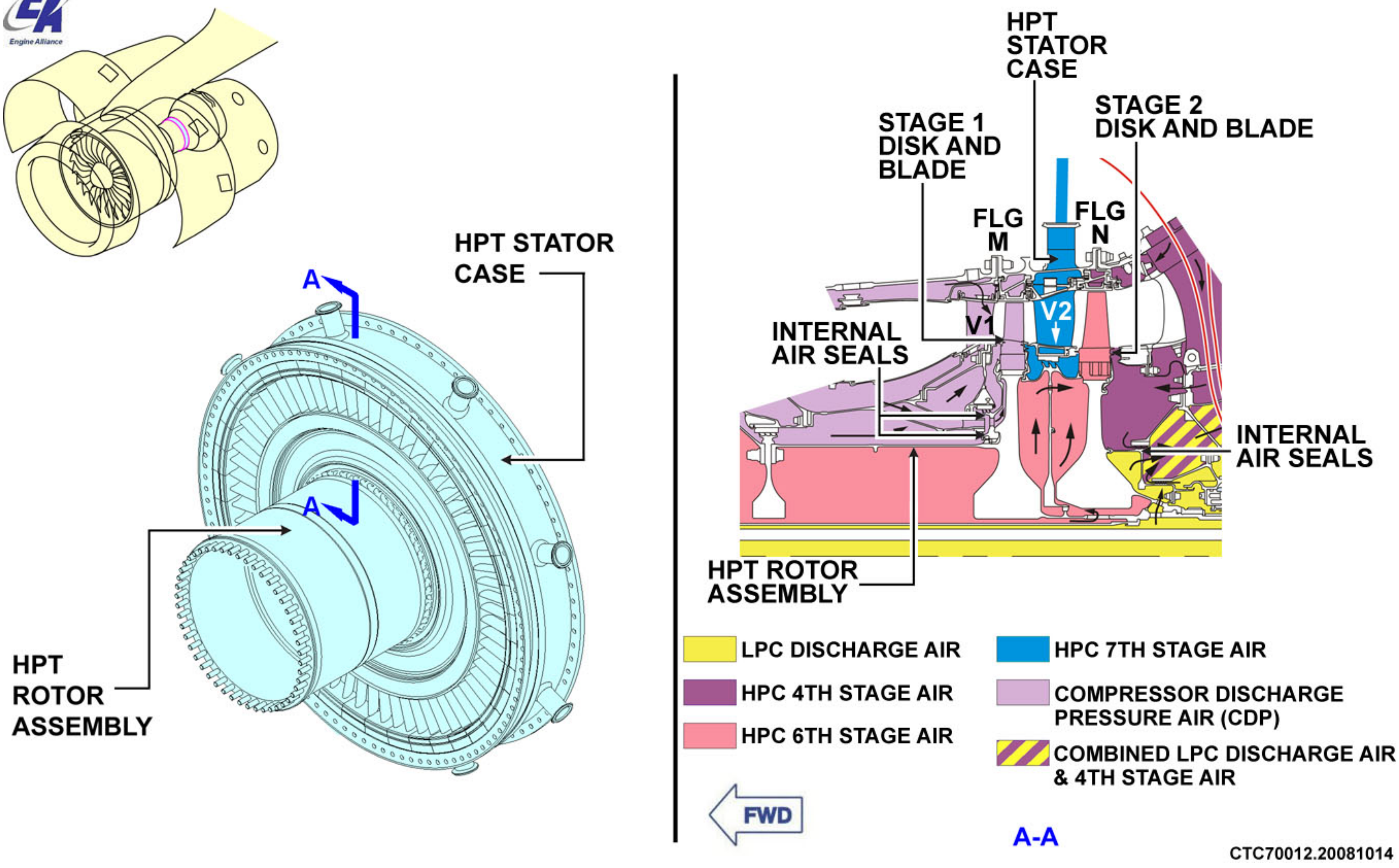
Turbine Section (continued)

High Pressure Turbine

Purpose:
- Changes the hot flow path gas energy into torque to operate the HPC rotor assembly.

Components:
- Two stage assembly:
. HPT stator case,
. Stage 1 disk and blade,
. Stage 2 disk and blade,
. Internal air seals,
. High Pressure Turbine Active Clearance Control (HPT ACC) manifolds.

Description:
- Two stage, axial flow design,
- Stage 1:
. Is an integral disk and forward shaft design that attaches to the CDP rotating seal of the HPC rotor assembly,
. Blades are internally air cooled by CDP air,
. Disk is externally air cooled by HPC 6th stage air and CDP air in the front, and HPC 6th stage air in the back.
- Stage 2:
. Mounts to the HPT rotor interstage seal,
. Blades are internally air cooled by HPC 6th stage air,
. Disk is externally air cooled by HPC 6th stage air in the front and HPC 4th stage air in the back,
. 2nd stage vane has provision for borescope.
- High Pressure Turbine Active Clearance Control (HPT ACC) manifolds supply cooling air externally around the HPT case.


HPT STATOR CASE
A
A
HPT ROTOR ASSEMBLY
HPT STATOR CASE
STAGE 1 DISK AND BLADE
STAGE 2 DISK AND BLADE
FLG M
FLG N
V1
V2
INTERNAL AIR SEALS
INTERNAL AIR SEALS
HPT ROTOR ASSEMBLY
LPC DISCHARGE AIR
HPC 4TH STAGE AIR
HPC 6TH STAGE AIR
HPC 7TH STAGE AIR
COMPRESSOR DISCHARGE PRESSURE AIR (CDP)
COMBINED LPC DISCHARGE AIR & 4TH STAGE AIR
FWD
A-A
CTC70012.20081014

TURBINE SECTION - HIGH PRESSURE TURBINE

BASIC ENGINE DESCRIPTION (EA) (3)

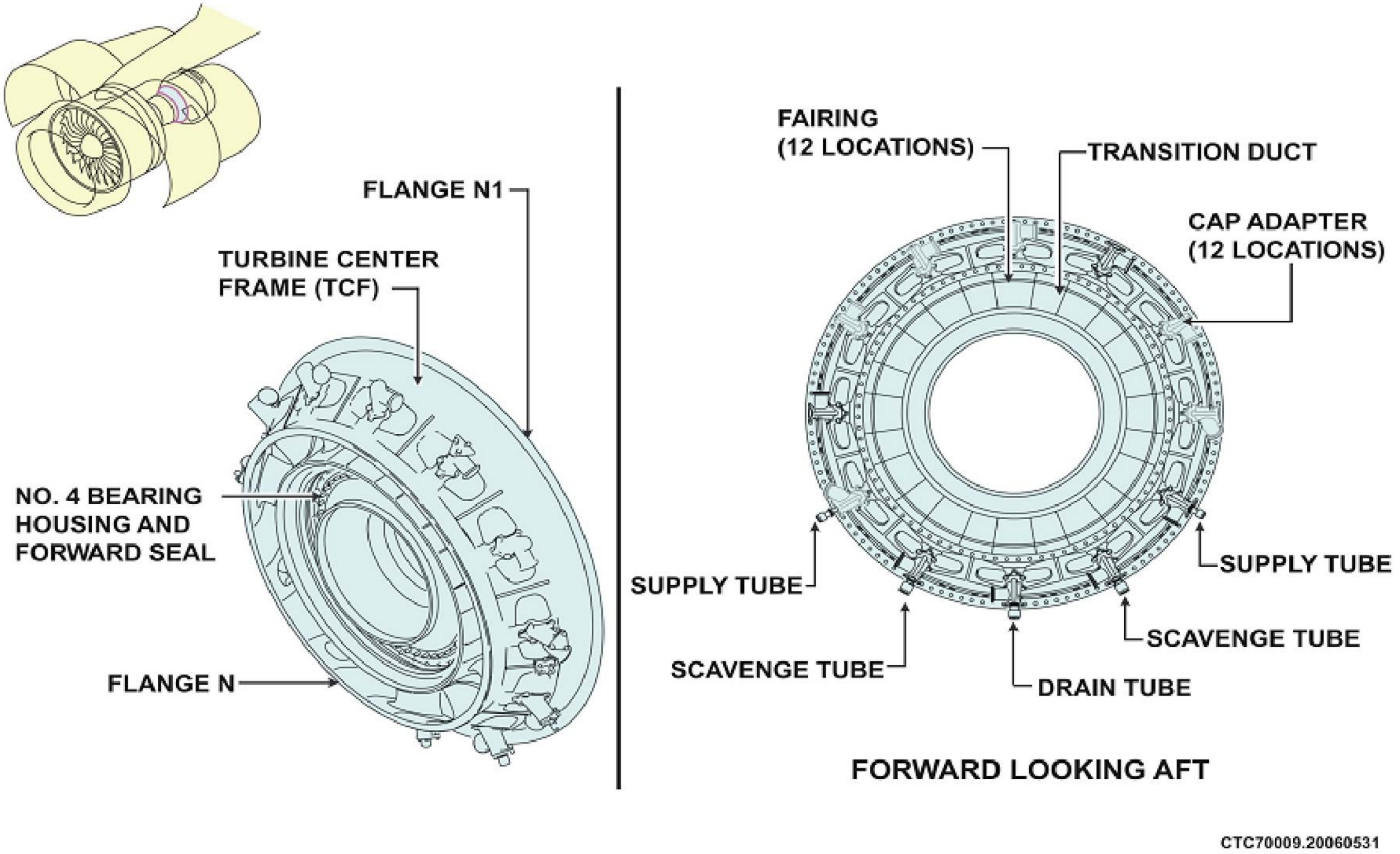
Turbine Section (continued)

Turbine Center Frame

Purpose:
- Provide turbine section structural support and airflow transition between the HPT and the LPT,
- Support the No. 4 bearing.

Components:
- Turbine center frame and subassemblies.

Description:
- Contains the No. 4 bearing and seal assembly,
- 12 cap adapter pads for HPC stage air for internal cooling,
- 5 service lines to the No. 4 bearing compartment:
. Scavenge oil tubes at 5 o'clock and 7 o'clock,
. Supply oil tubes at 4 o'clock and 8 o'clock,
. Drain tube at 6 o'clock.


FLANGE N1
TURBINE CENTER FRAME (TCF)
NO. 4 BEARING HOUSING AND FORWARD SEAL
FLANGE N
FAIRING (12 LOCATIONS)
TRANSITION DUCT
CAP ADAPTER (12 LOCATIONS)
SUPPLY TUBE
SUPPLY TUBE
SCAVENGE TUBE
SCAVENGE TUBE
DRAIN TUBE
FORWARD LOOKING AFT
CTC70009.20060531

TURBINE SECTION - TURBINE CENTER FRAME

BASIC ENGINE DESCRIPTION (EA) (3)

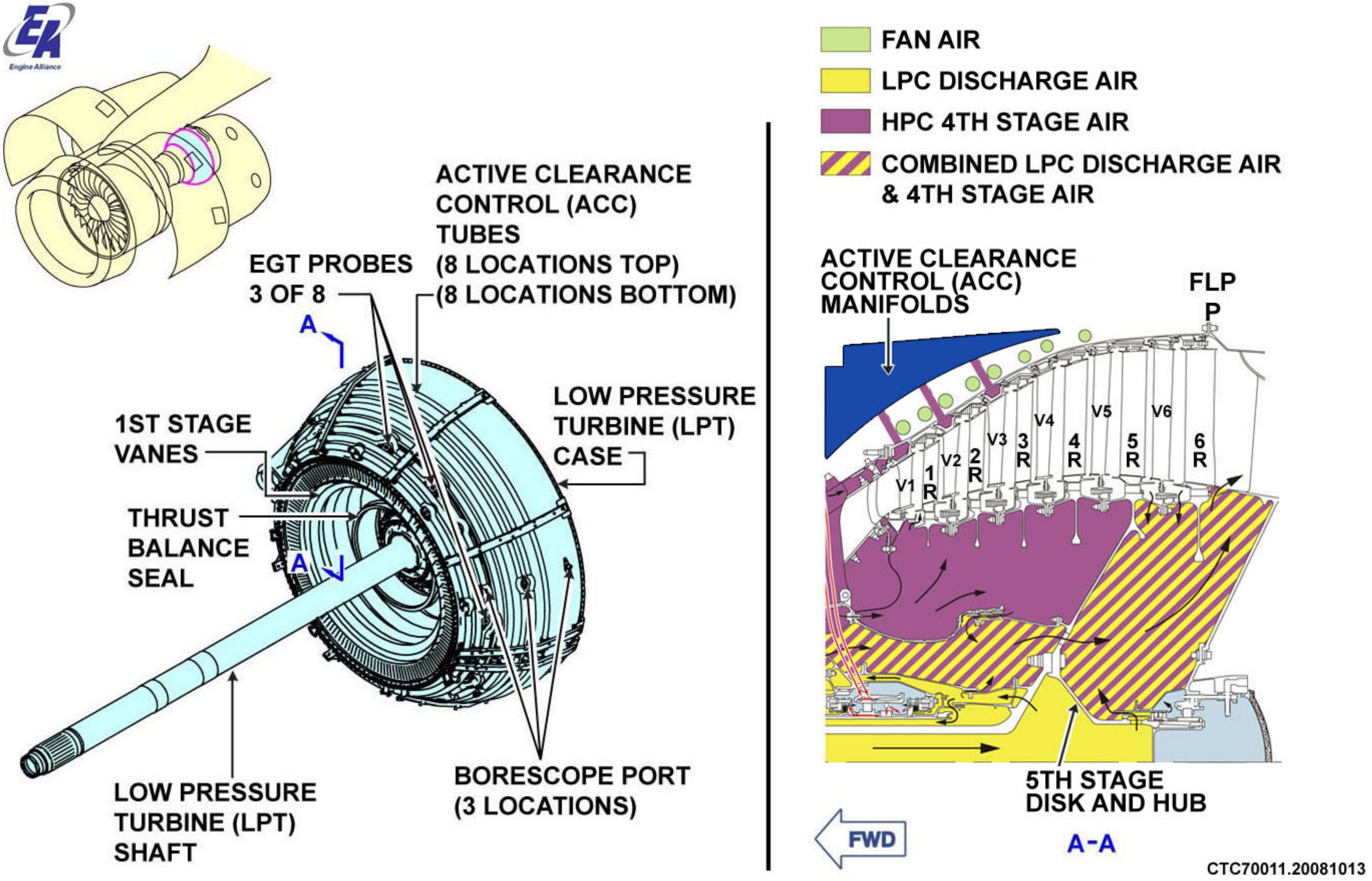
Turbine Section (continued)

Low Pressure Turbine

Purpose:
- Supplies the rotational force for the LPC and fan rotor.

Components:
- LPT case,
- LPT shaft,
- ACC manifolds,
- Stage 1 - 6 vanes,
- Stage 1 - 6 disks and blades.

Description:
- The 5th stage rotor disk is the primary rotating structure and is the attaching point for the other disks and the LPT shaft:
. The 1st, 2nd, 3rd, and 4th stage disks are cantilevered forward of the 5th stage disk,
. The 6th stage disk is cantilevered rearward of the 5th stage disk,
. The LPT shaft is bolted to the front of the 5th stage disk.
- External air cooling of the LPT 1st, 2nd, 3rd, 4th disk and vane inner diameters and front of the 5th disk is provided by HPC 4th stage air,
- External air cooling of the 5th and 6th disk and vane inner diameters and the rear of the 5th disk is provided by a mixture of LPC discharge and HPC 4th stage air,
- Low Pressure Turbine Active Clearance Control (LPT ACC) manifolds supply cooling air externally around the LPT case,
- 8 EGT probes are located in the LPT case, and sense the gas temperature at the 2nd stage vanes,
- 3 borescope bosses are mounted on the LPT case.


Engine Alliance
ACTIVE CLEARANCE CONTROL (ACC) TUBES (8 LOCATIONS TOP) (8 LOCATIONS BOTTOM)
EGT PROBES 3 OF 8
A
1ST STAGE VANES
THRUST BALANCE SEAL
A
LOW PRESSURE TURBINE (LPT) CASE
LOW PRESSURE TURBINE (LPT) SHAFT
BORESCOPE PORT (3 LOCATIONS)
🟩 FAN AIR
🟨 LPC DISCHARGE AIR
🟪 HPC 4TH STAGE AIR
▨ COMBINED LPC DISCHARGE AIR & 4TH STAGE AIR
ACTIVE CLEARANCE CONTROL (ACC) MANIFOLDS
FLP P
V1
1 R
V2
2 R
V3
3 R
V4
4 R
V5
5 R
V6
6 R
5TH STAGE DISK AND HUB
FWD
A-A
CTC70011.20081013

TURBINE SECTION - LOW PRESSURE TURBINE

BASIC ENGINE DESCRIPTION (EA) (3)

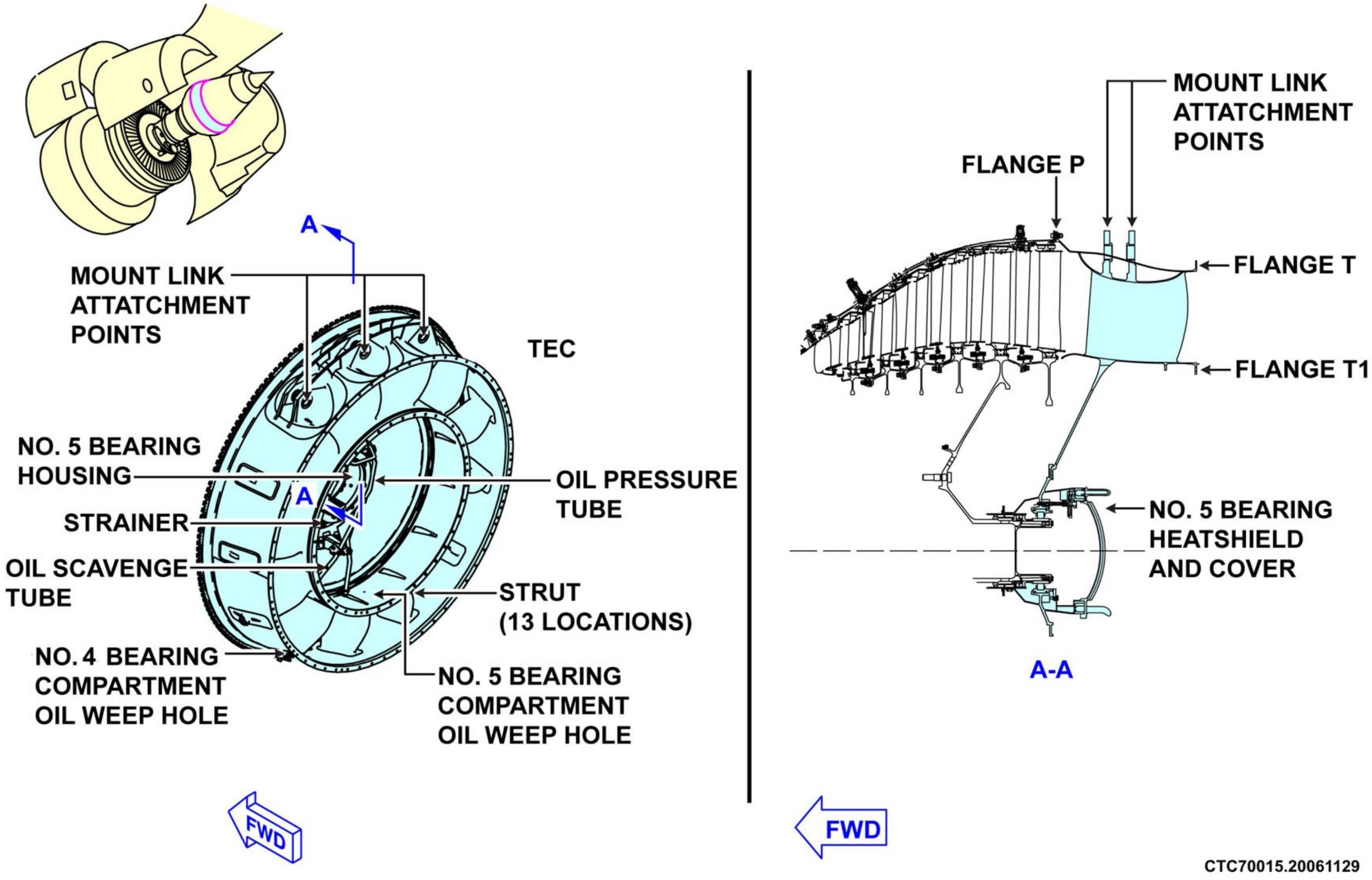
Turbine Section (continued)

Turbine Exhaust Case

Purpose:
- Supplies structural support for the rear of the engine,
- Supports the No. 5 bearing,
- Acts as the transition duct between the LPT and the exhaust nozzle, and straightens the exhaust gas flow as it exits the engine,
- Supports turbine exhaust cone and plug.

Components:
- Turbine exhaust case,
- No. 5 bearing,
- No. 5 bearing housing.

Description:
- Has three engine to aircraft mount link attachment points at 11 o'clock, 12 o'clock, and 1 o'clock,
- Contains the No. 5 bearing and seal assembly,
- There are 2 service lines to the No. 5 bearing compartment:
. Scavenge oil tube at 7 'clock,
. Supply oil tube at 6:30 o'clock.
- No. 4 and No. 5 bearing compartments weep holes.


MOUNT LINK
ATTATCHMENT
POINTS
A
TEC
NO. 5 BEARING
HOUSING
A
STRAINER
OIL SCAVENGE
TUBE
NO. 4 BEARING
COMPARTMENT
OIL WEEP HOLE
OIL PRESSURE
TUBE
STRUT
(13 LOCATIONS)
NO. 5 BEARING
COMPARTMENT
OIL WEEP HOLE
FWD
MOUNT LINK
ATTATCHMENT
POINTS
FLANGE P
FLANGE T
FLANGE T1
NO. 5 BEARING
HEATSHIELD
AND COVER
A-A
FWD
CTC70015.20061129

TURBINE SECTION - TURBINE EXHAUST CASE

BASIC ENGINE DESCRIPTION (EA) (3)

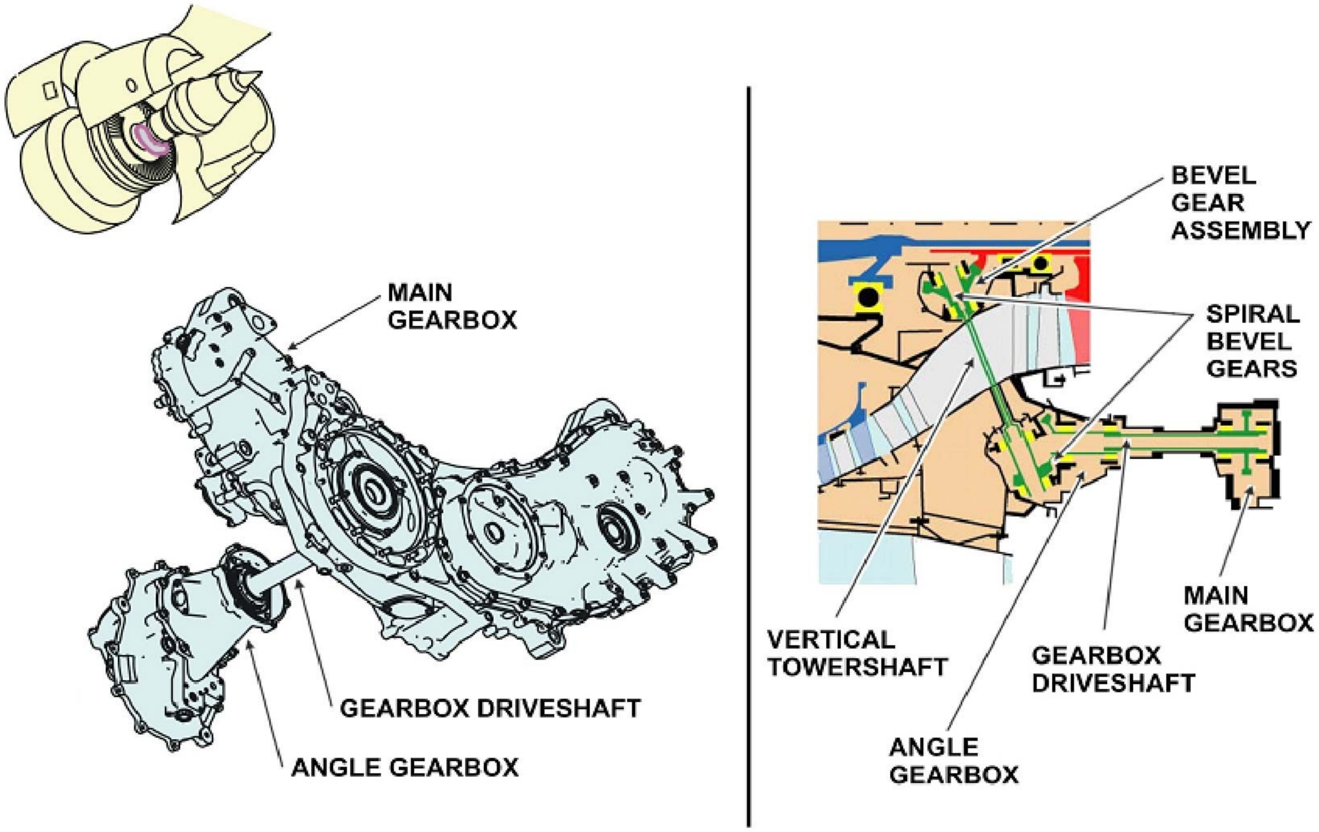
Accessory Drive Section

Accessory Drive Section - General

Purpose:
- Transmits power from the HPC rotor to the engine and aircraft accessories.

Components:
- Angle gearbox,
- Main gearbox,
- Gearbox driveshaft.

Drive train components from the HPC to the angle gearbox:
- Bevel gear assembly,
- Spiral bevel gears,
- Vertical towershaft.


MAIN GEARBOX
GEARBOX DRIVESHAFT
ANGLE GEARBOX
BEVEL GEAR ASSEMBLY
SPIRAL BEVEL GEARS
MAIN GEARBOX
VERTICAL TOWERSHAFT
GEARBOX DRIVESHAFT
ANGLE GEARBOX

CTC70048.20060718

ACCESSORY DRIVE SECTION - ACCESSORY DRIVE SECTION - GENERAL

BASIC ENGINE DESCRIPTION (EA) (3)

Accessory Drive Section (continued)

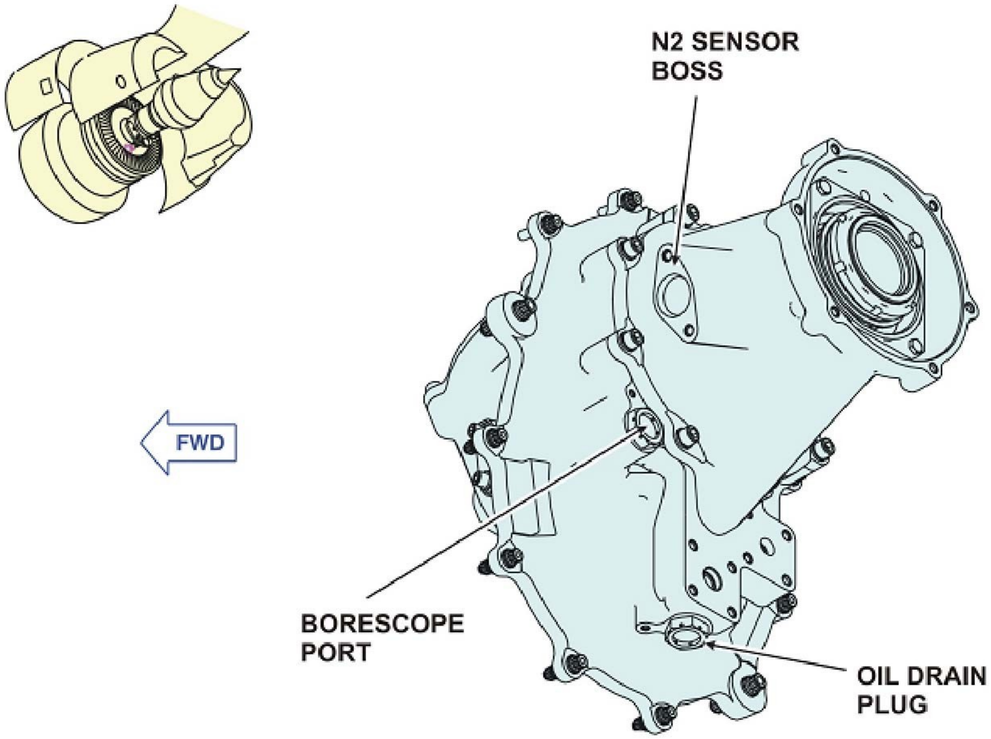
Angle Gearbox

Purpose:
- Transmits power from the HPC rotor to the main gearbox.

Components:
- Angle Gearbox.

Description:
- Angle Gearbox:

. Mounts to the rear of the Fan Hub Frame (FHF) at 6 o'clock,
. An oil drain plug is located at the bottom of the AGB,
. A borescope port is located at 8 o'clock,
. The N2 speed sensor is located at 9 o'clock,
. The internal gears and bearings receive pressure and splash lubrication.


N2 SENSOR BOSS
FWD
BORESCOPE PORT
OIL DRAIN PLUG

CTC70047.20060718

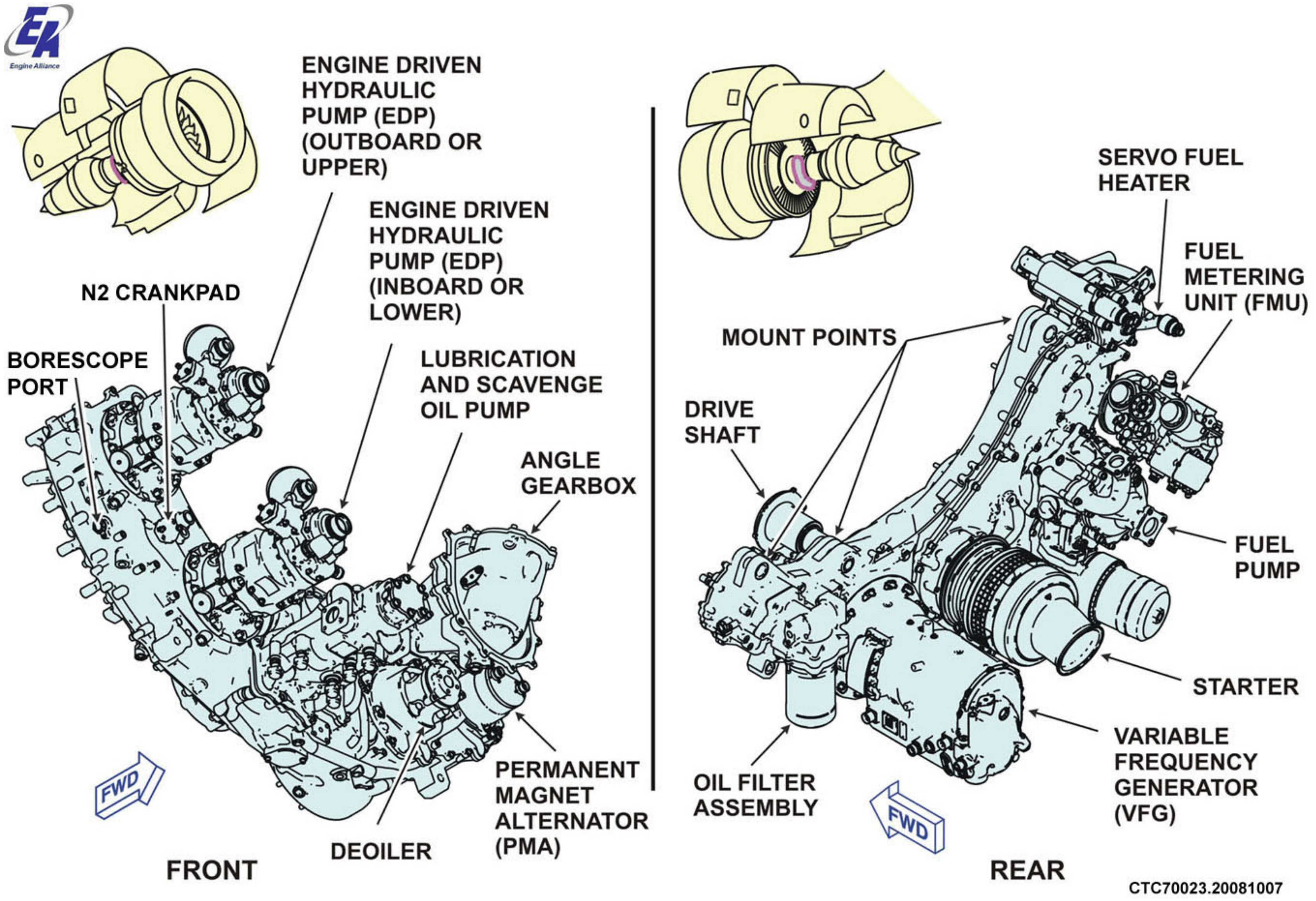
ACCESSORY DRIVE SECTION - ANGLE GEARBOX

BASIC ENGINE DESCRIPTION (EA) (3)

Accessory Drive Section (continued)

Main Gearbox

Purpose:
- Transmits power from the HPC rotor, via the AGB and cross shaft, to the aircraft and engine accessories,
- Provides component mount provision.
Components:
- Main Gearbox.
Description:
- Mounts to the Fan Hub Frame and the HPC Case,
- The internal gears and bearings receive pressure and splash lubrication,
- Provides drive pads for the:
. Variable Frequency Generator (VFG) - R,
. Starter - R,
. N2 Manual Crank Pad - F,
. Two Engine Driven Hydraulic Pumps - F,
. Fuel Pump - R,
. Lubrication and Scavenge Oil Pump - F,
. Deoiler - F,
. Permanent Magnet Alternator - F.
- Accessory spline lubrication is supplied by oil jets to the center of the accessory shafts,
- Two borescope ports are located at 4:30 and 7:30,
- Provides accessory mount pad overboard drains for the:
. Hydraulic pumps,
. Starter,
. VFG,
. Fuel Pump.
- Provides mounting provision for:
. Fuel Metering Unit - R,
. Oil filter - R,
. Servo/fuel heater - R,
Note: R = Rear, F= Front.


Engine Alliance
ENGINE DRIVEN HYDRAULIC PUMP (EDP) (OUTBOARD OR UPPER)
ENGINE DRIVEN HYDRAULIC PUMP (EDP) (INBOARD OR LOWER)
N2 CRANKPAD
BORESCOPE PORT
LUBRICATION AND SCAVENGE OIL PUMP
ANGLE GEARBOX
PERMANENT MAGNET ALTERNATOR (PMA)
DEOILER
FWD
FRONT
SERVO FUEL HEATER
FUEL METERING UNIT (FMU)
MOUNT POINTS
DRIVE SHAFT
FUEL PUMP
STARTER
VARIABLE FREQUENCY GENERATOR (VFG)
OIL FILTER ASSEMBLY
FWD
REAR
CTC70023.20081007

ACCESSORY DRIVE SECTION - MAIN GEARBOX

BASIC ENGINE DESCRIPTION (EA) (3)

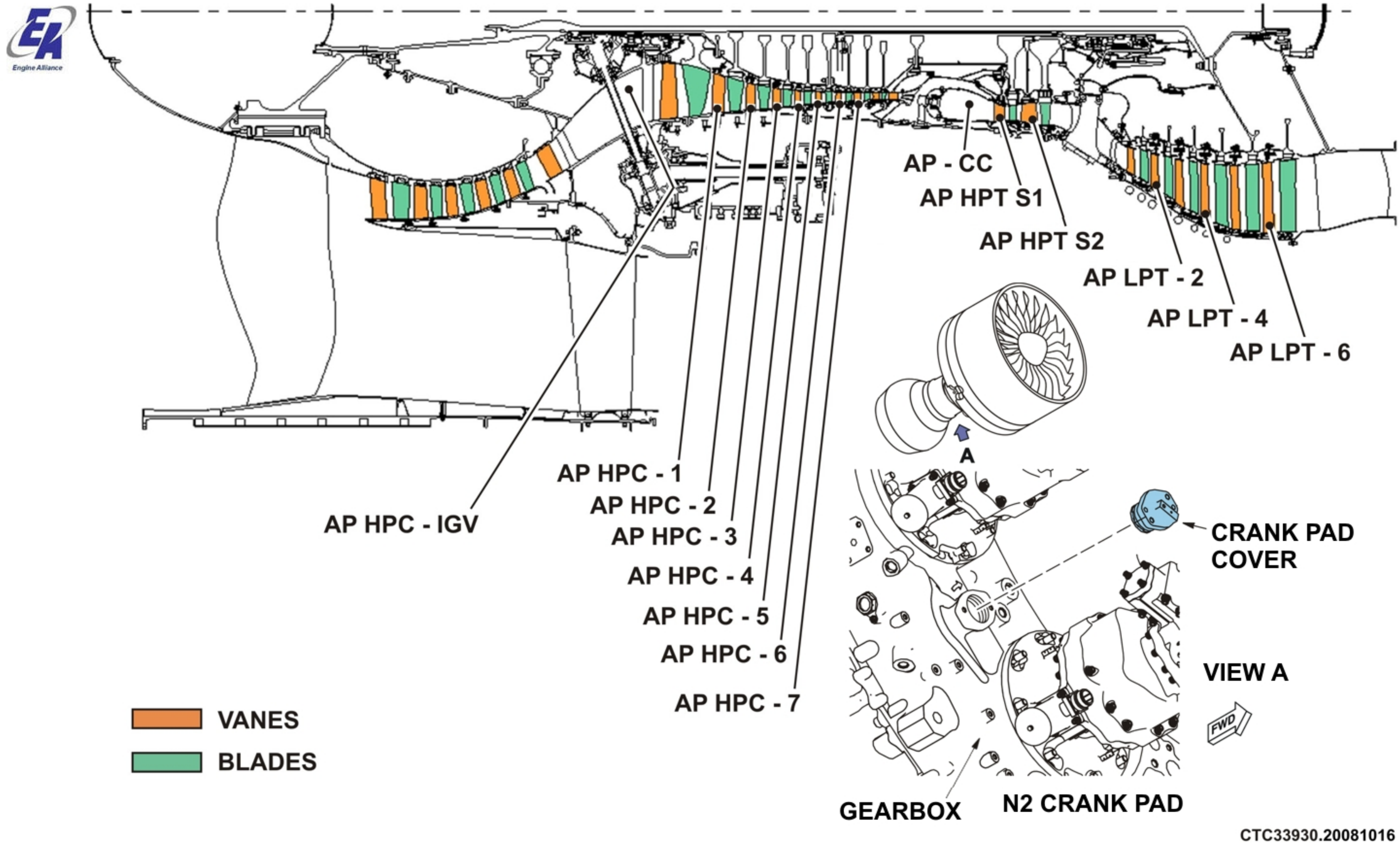
Borescope

Borescope - General

Purpose:
- Provides access to the internal parts.

Description:
- When possible, inspection access to internal parts is through functional openings. When this is not possible, borescope access ports are added to the engine/component design.
- There are 17 borescope inspection access ports to examine the very important parts in the engine gas path.
- There is also access through the fan blades and between the turbine exhaust struts for borescope inspection.
- During High Pressure Compressor (HPC)/High Pressure Turbine (HPT) borescope inspection a 9/16" socket is used to turn the gearbox crankpad to turn the N2 rotor.
- There is one borescope inspection access port to inspect the inside of the angle gearbox.
- There are two borescope inspection access ports to inspect the inside of the main gearbox.
- All borescope plugs have an AP (Access Port) designation.
- All AP plugs are identified by the engine section and rear view of the applicable stage that can be seen with the borescope.
- Example:

. AP HPC-7 is the rear view of the HPC 7th stage blade.

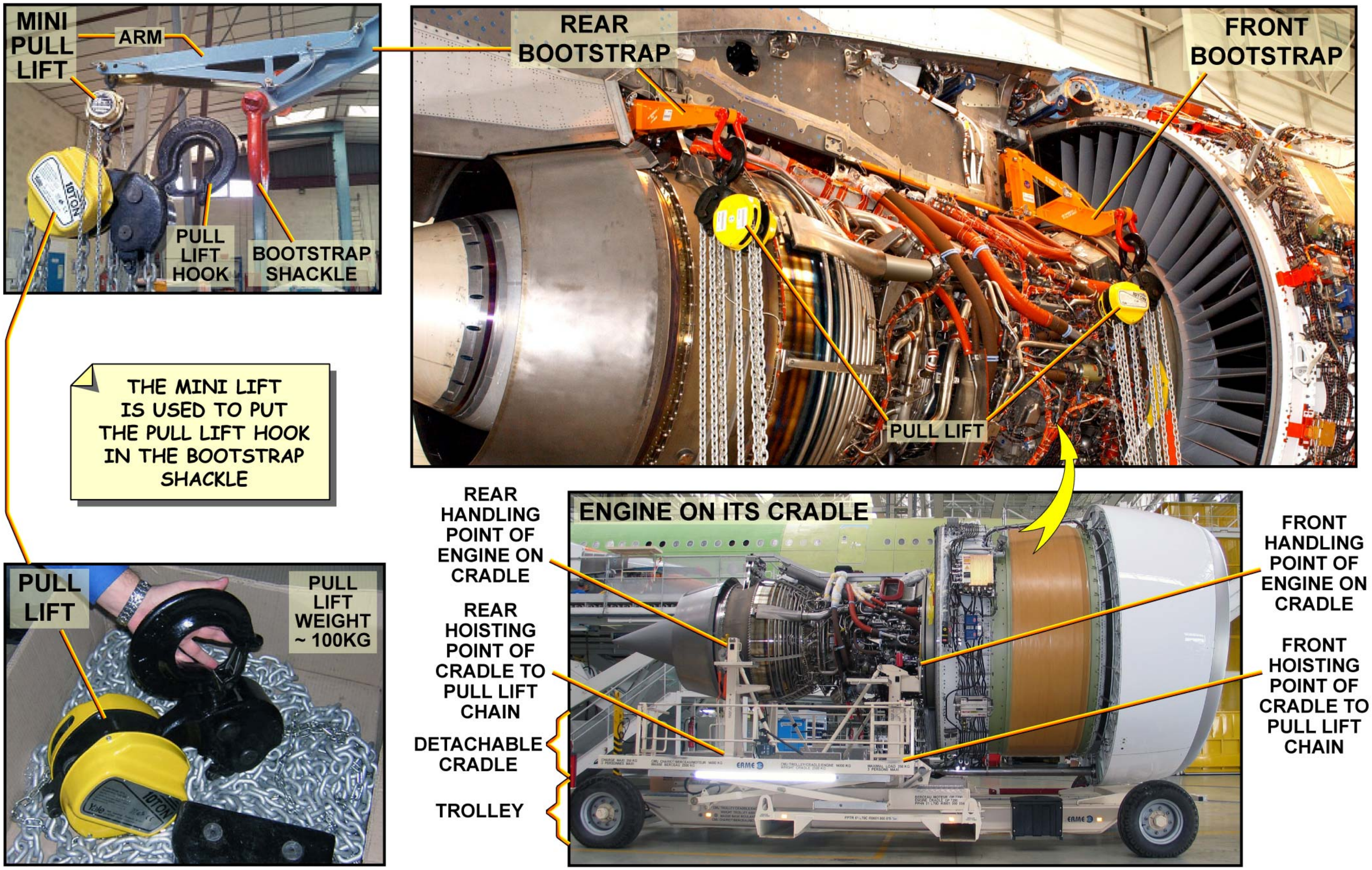

AP - CC
AP HPT S1
AP HPT S2
AP LPT - 2
AP LPT - 4
AP LPT - 6
AP HPC - IGV
AP HPC - 1
AP HPC - 2
AP HPC - 3
AP HPC - 4
AP HPC - 5
AP HPC - 6
AP HPC - 7
🟧 VANES
🟩 BLADES
A
CRANK PAD COVER
VIEW A
FWD
GEARBOX
N2 CRANK PAD
CTC33930.20081016

BORESCOPE - BORESCOPE - GENERAL

POWER PLANT INSTALLATION DESCRIPTION (3)

Bootstrap System Installation

The removal and installation of the engine requires the installation of a bootstrap system on the aircraft pylon.
The bootstrap system is composed of two main assemblies, to be installed at the front and at the rear of the pylon.
Each bootstrap assembly permits to attach at its ends the pull lifts to lower or to lift the engine via its cradle.
Due to the weight of the pull lifts (equipped with 6 meter chain long), approximately 100 Kg each one, a mini pull lift is used to put the pull lift hooks in the Bootstrap shackles.
The pull lifts, installed on the bootstraps, are used to perform the handling of the detachable cradle from or to its trolley.


MINI PULL LIFT
ARM
PULL LIFT HOOK
BOOTSTRAP SHACKLE
REAR BOOTSTRAP
FRONT BOOTSTRAP
PULL LIFT
PULL LIFT
PULL LIFT WEIGHT ~ 100KG
ENGINE ON ITS CRADLE
REAR HANDLING POINT OF ENGINE ON CRADLE
REAR HOISTING POINT OF CRADLE TO PULL LIFT CHAIN
DETACHABLE CRADLE
TROLLEY
FRONT HANDLING POINT OF ENGINE ON CRADLE
FRONT HOISTING POINT OF CRADLE TO PULL LIFT CHAIN

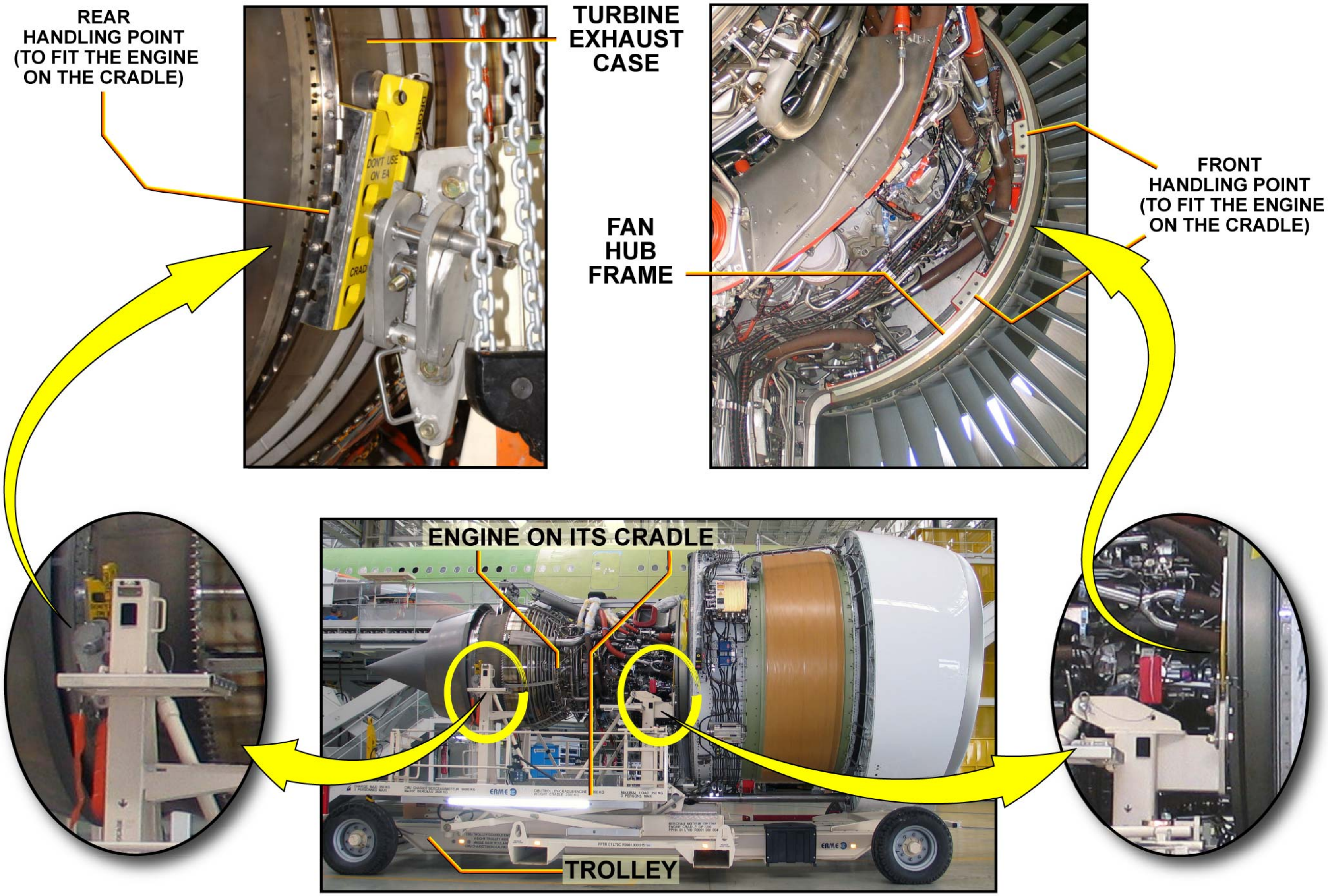
THE MINI LIFT IS USED TO PUT THE PULL LIFT HOOK IN THE BOOTSTRAP SHACKLE

BOOTSTRAP SYSTEM INSTALLATION

POWER PLANT INSTALLATION DESCRIPTION (3)

Engine Transportation and Handling Points

The engine transportation assembly consists of a trolley equipped with a detachable cradle.
This assembly is used to perform the engine removal and installation.
The handling points used to attach the engine on the cradle are distributed on four zones
- two front zones on the fan hub frame, LH and RH side and,
- two rear zones on the turbine exhaust case, LH and RH side.


REAR HANDLING POINT (TO FIT THE ENGINE ON THE CRADLE)
TURBINE EXHAUST CASE
DON'T USE ON EA
FAN HUB FRAME
FRONT HANDLING POINT (TO FIT THE ENGINE ON THE CRADLE)
ENGINE ON ITS CRADLE
TROLLEY

ENGINE TRANSPORTATION AND HANDLING POINTS

POWER PLANT INSTALLATION DESCRIPTION (3)

Engine Mounts

Three mount assemblies attach the engine to the pylon primary structure (also called pylon box).
These engine mount assemblies have four functions:
- To support the weight of the engine
- To make sure that the engine does not turn around its axis,
- To hold lateral loads,
- To transmit the thrust of the engine to the pylon.

The engine mount assembly has three main components:
- The forward mount assembly
- The aft mount assembly
- The thrust mount assembly

Each engine mount assembly is made to be fail-safe or dual load path.
Each spherical bearing of mounts lets:
- Mainly axial thermal expansion between the engine and the aircraft pylon
- Some movement between the engine and the aircraft pylon

Forward Mount Assembly

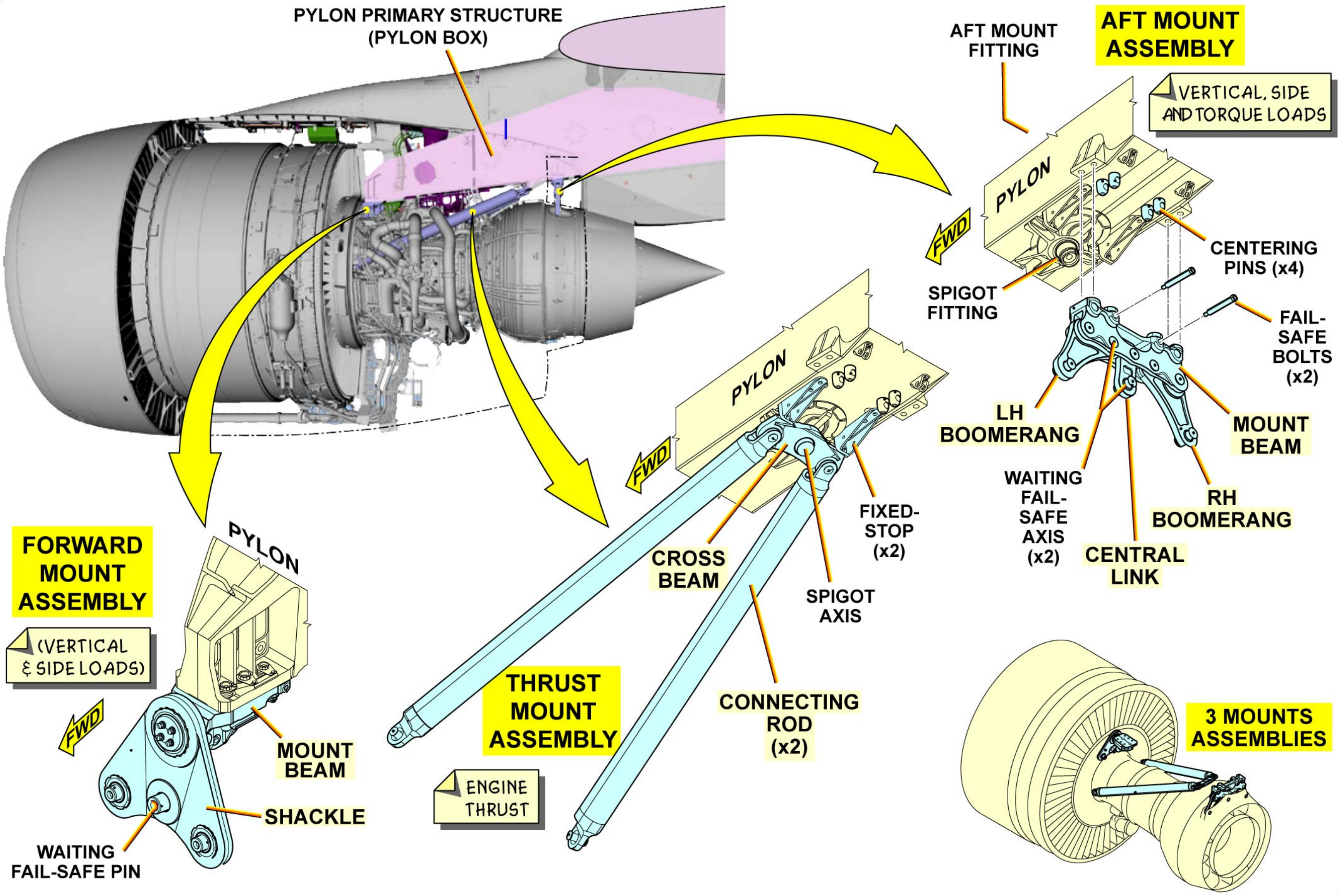
The forward mount assembly carries the vertical and side loads.
It attaches the fan hub frame of the engine to the forward end of the pylon.
It is composed of two main components: the shackle and the mount beam sub assemblies
The forward mount assembly has a weight of about 52 kg (115 lb).

Aft Mount Assembly

The aft mount assembly carries the vertical, side and torque loads.
The aft mount assembly is installed between the engine and the pylon.
It attaches the top of the turbine exhaust case to the lower part of the pylon.
It is composed of four main components: a monolithic aft mount beam, two boomerangs (left and right) and a central link
The aft mount assembly has a weight of approximately 82 kg (181 lb

Thrust Mount Assembly

The thrust mount assembly transmits the thrust of the engine to the pylon.
This assembly is installed between the engine and the pylon.
It attaches each side of the fan hub frame to the lower part of the pylon at the spigot fitting (just in front of the rear mount).
It is composed of three main components: two connecting rods and one cross beam.
The cross beam ensure the link between the two connecting rods and the spigot by distributing the strength in the two rods.
For an engine removal / installation the thrust mount assembly remains fitted on the engine, it is part of the Quick Engine Change (QEC).
The thrust mount assembly has a weight of about 80 kg (176 lb).

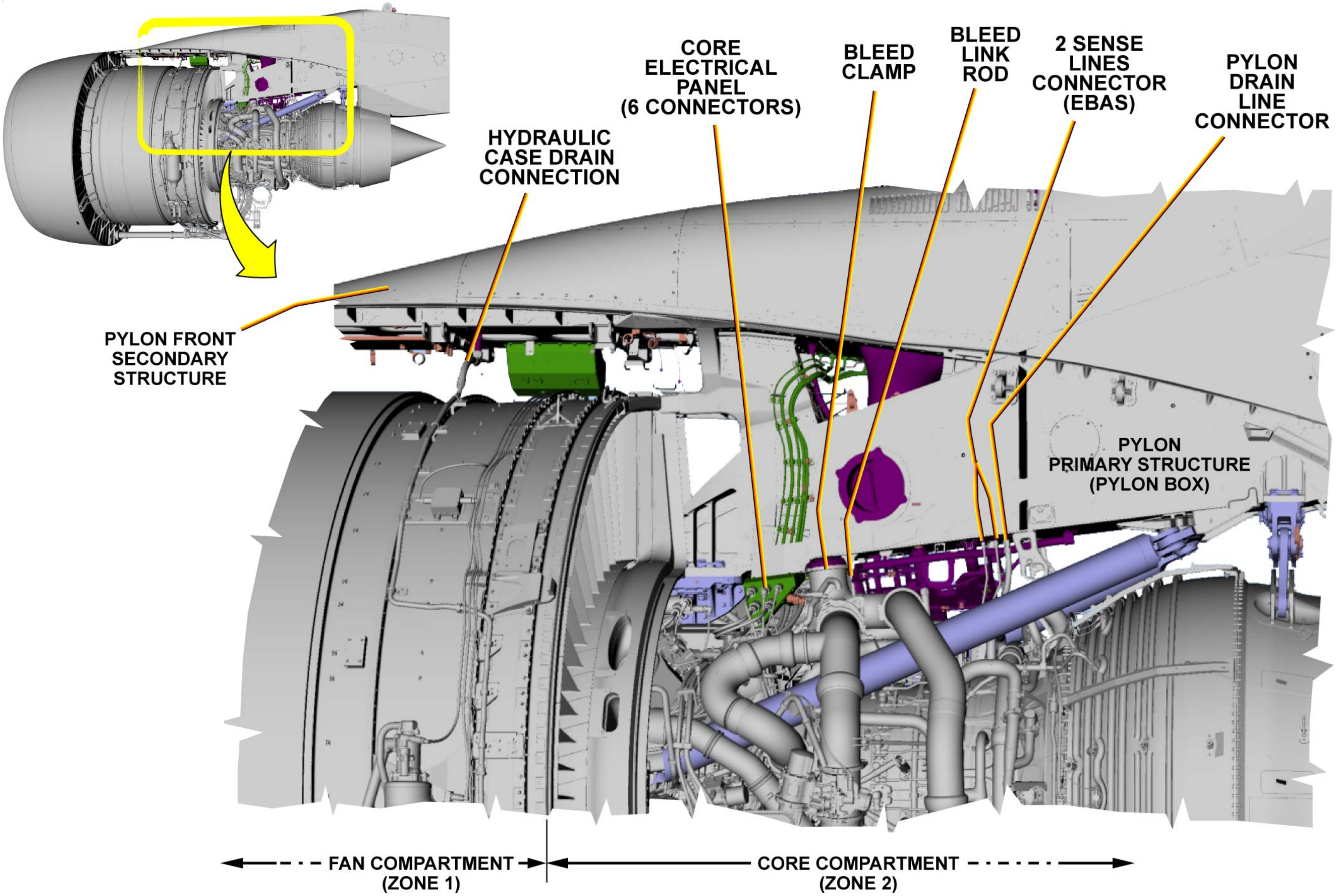

PYLON PRIMARY STRUCTURE
(PYLON BOX)
AFT MOUNT
FITTING
AFT MOUNT
ASSEMBLY
VERTICAL, SIDE
AND TORQUE LOADS
PYLON
FWD
CENTERING
PINS (x4)
SPIGOT
FITTING
FAIL-
SAFE
BOLTS
(x2)
LH
BOOMERANG
MOUNT
BEAM
WAITING
FAIL-
SAFE
AXIS
(x2)
RH
BOOMERANG
CENTRAL
LINK
PYLON
FWD
FIXED-
STOP
(x2)
CROSS
BEAM
SPIGOT
AXIS
CONNECTING
ROD
(x2)
THRUST
MOUNT
ASSEMBLY
ENGINE
THRUST
PYLON
FORWARD
MOUNT
ASSEMBLY
(VERTICAL
& SIDE LOADS)
FWD
MOUNT
BEAM
SHACKLE
WAITING
FAIL-SAFE PIN
3 MOUNTS
ASSEMBLIES

ENGINE MOUNTS - FORWARD MOUNT ASSEMBLY ... THRUST MOUNT ASSEMBLY

POWER PLANT INSTALLATION DESCRIPTION (3)

Pylon to Engine Connections on LH Side

On the engine LH Side, in the fan compartment (zone1), under the pylon front secondary structure there is access to the connection of the hydraulic case drain line.
On the engine LH Side, in the core compartment (zone 2), under the pylon primary structure (pylon box) there is access to:
- the core electrical panel provided with 6 connectors,
- the bleed clamp, note that the part of the bleed system located under the clamp, is supported by a bleed link rod,
- 2 connectors for senses lines dedicated to the control of the Engine Bleed Air System (EBAS) and
- a connector for a pylon drain line.


HYDRAULIC CASE DRAIN CONNECTION
CORE ELECTRICAL PANEL (6 CONNECTORS)
BLEED CLAMP
BLEED LINK ROD
2 SENSE LINES CONNECTOR (EBAS)
PYLON DRAIN LINE CONNECTOR
PYLON FRONT SECONDARY STRUCTURE
PYLON PRIMARY STRUCTURE (PYLON BOX)
FAN COMPARTMENT (ZONE 1)
CORE COMPARTMENT (ZONE 2)

PYLON TO ENGINE CONNECTIONS ON LH SIDE

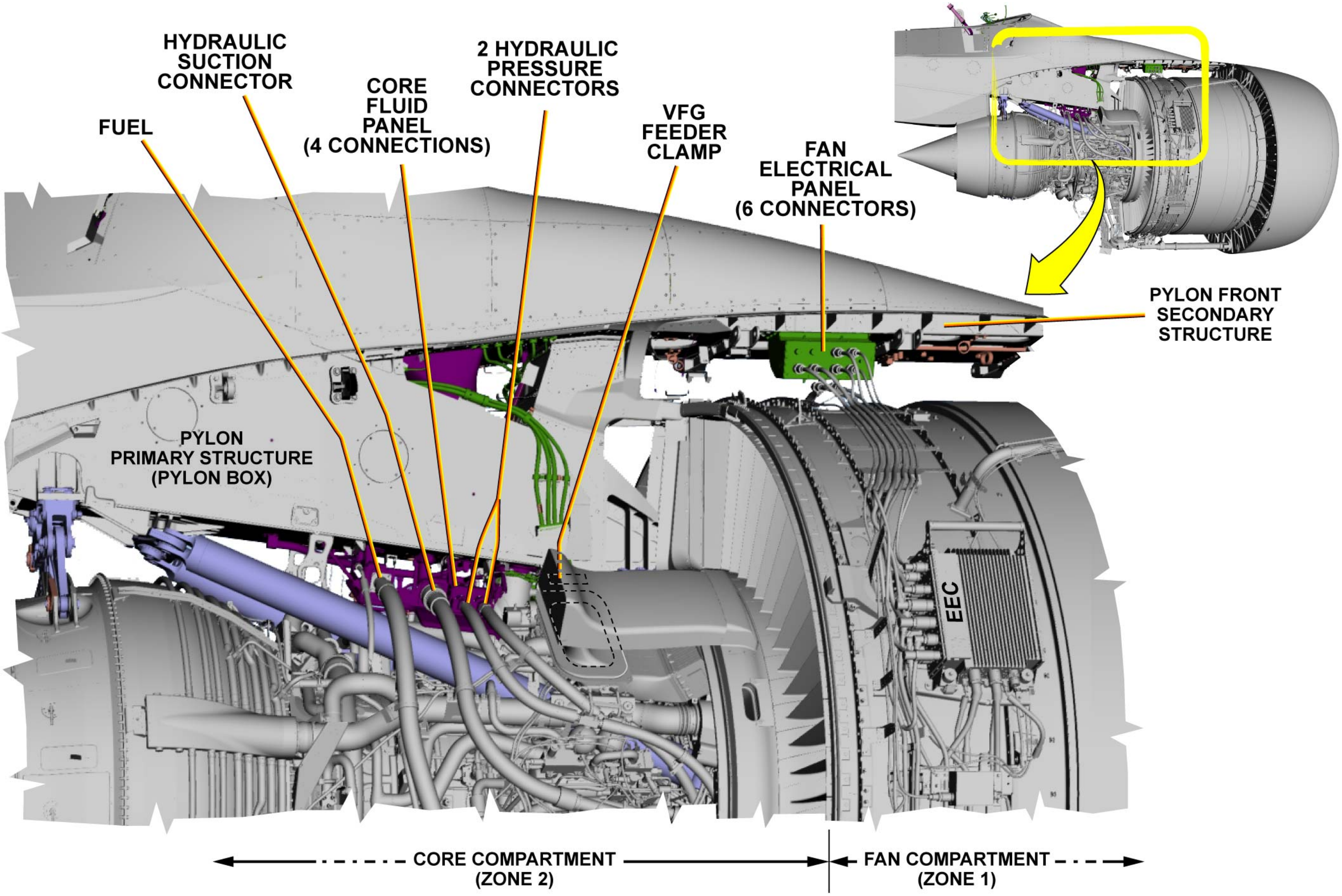
LB408521 - L5CT0T0 - LM7ED9000000001

POWER PLANT INSTALLATION DESCRIPTION (3)

Pylon to Engine Connections on RH Side

On the engine RH Side, in the fan compartment (zone1), under the pylon front secondary structure there is access to the fan electrical panel provided with 6 connectors.
On the engine RH Side, in the core compartment (zone 2), under the pylon primary structure (pylon box) there is access to:
- the VFG (Variable Frequency Generator) feeder clamp and
- the core fluid panel provided with 4 connections.

The core fluid panel provides connection for the fuel feed line, the hydraulic suction line and the 2 hydraulic pressure lines.


HYDRAULIC SUCTION CONNECTOR
2 HYDRAULIC PRESSURE CONNECTORS
CORE FLUID PANEL (4 CONNECTIONS)
FUEL
VFG FEEDER CLAMP
FAN ELECTRICAL PANEL (6 CONNECTORS)
PYLON FRONT SECONDARY STRUCTURE
PYLON PRIMARY STRUCTURE (PYLON BOX)
EEC
CORE COMPARTMENT (ZONE 2)
FAN COMPARTMENT (ZONE 1)

PYLON TO ENGINE CONNECTIONS ON RH SIDE

LB408521 - L5CT0T0 - LM7ED9000000001

NACELLE & ENGINE MAINTENANCE (EA) (3)

Fan Blade Removal

Task

Remove fan blade(s).

Standard Tools

Cart, Storage - Fan Blades,
Protective Mat,
Protective Covers.

Special Tools

PWA 105132 - Puller, Knocker:
- Fan blade spacer.
PWA 106201 - Compressor, Mechanical - Pliers and Wedge:
- Fan blade lock ring.

Precautions

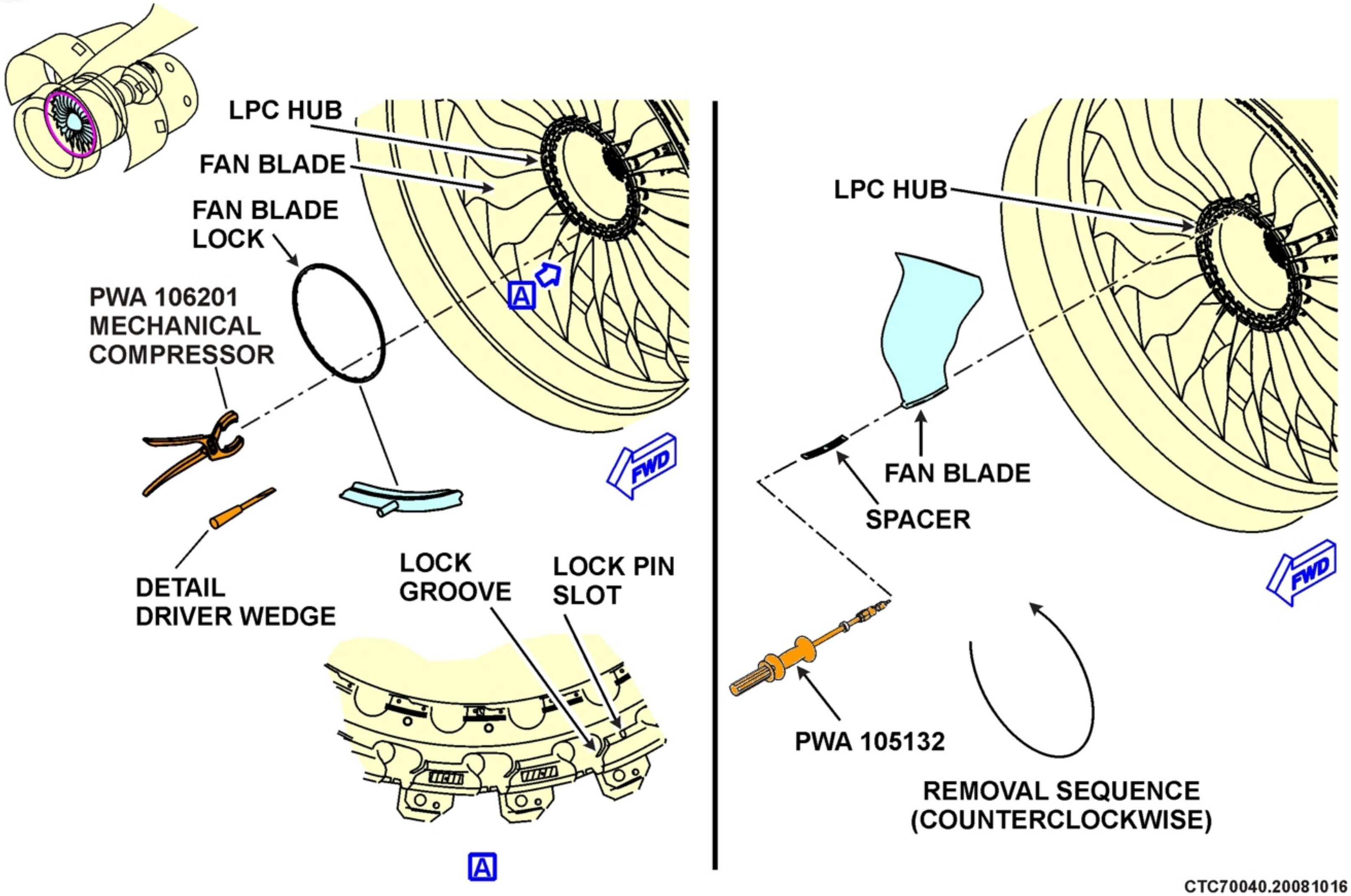
WARNING: BE CAREFUL WHEN YOU WORK ON THE ENGINE AFTER SHUTDOWN. THE ENGINE AND ENGINE OIL CAN STAY HOT FOR A LONG TIME. IF YOU DO NOT OBEY THIS WARNING, INJURY CAN OCCUR.
WARNING: REFER TO THE MSDS FOR ALL MATERIAL USED AND THE MANUFACTURER'S SAFETY INSTRUCTIONS FOR ALL EQUIPMENT USED. IF YOU DO NOT OBEY THIS WARNING, INJURY CAN OCCUR.
WARNING: USE GLOVES TO PREVENT POSSIBLE INJURY TO THE HANDS WHEN YOU HOLD THE FAN BLADES. THE BLADE EDGES ARE SHARP. IF YOU DO NOT, YOU CAN CUT YOUR HANDS.
WARNING: REMOVE THE BLADES AT THE TOP LOCATIONS AND WORK DOWN TO THE BOTTOM. LET THE ROTOR TURN SO THAT THE EMPTY BLADE SLOTS ARE AT THE TOP. DO NOT LET THE ROTOR BECOME TOP HEAVY AND ACCIDENTALLY TURN. IF YOU CO NOT OBEY THIS WARNING, INJURY CAN OCCUR.
CAUTION: INSTALL PROTECTION COVERS ON ALL OPENINGS IMMEDIATELY TO PREVENT DAMAGE TO THE ENGINE.
CAUTION: WHEN YOU REMOVE THE BLADES, CAREFULLY MOVE THEM FORWARD SO THAT THE TIPS DO NOT TOUCH THE ACOUSTIC LINER IN FRONT OF THE RUB STRIP. IF YOU DO NOT OBEY THIS CAUTION, DAMAGE CAN OCCUR.

Prerequisite Tasks

Remove the inlet cone,
Remove the fan fairings.

Key Steps

Install protective mat(s) and protective covers as required,
Remove the fan blade fairings,
Remove the fan blade lock,
Number the blades and corresponding hub position,
Remove the spacers,
Remove the fan blades,
Put the fan blades in the storage cart.


LPC HUB
FAN BLADE
FAN BLADE LOCK
PWA 106201 MECHANICAL COMPRESSOR
DETAIL DRIVER WEDGE
LOCK GROOVE
LOCK PIN SLOT
A
FWD
LPC HUB
FAN BLADE
SPACER
PWA 105132
REMOVAL SEQUENCE (COUNTERCLOCKWISE)
FWD
CTC70040.20081016

FAN BLADE REMOVAL - TASK ... KEY STEPS

NACELLE & ENGINE MAINTENANCE (EA) (3)

Fan Blade Installation

Task

Install fan blade(s).

Standard Tools

Cart, Storage - Fan Blades,
Protective Mat,
Protective Covers.

Special Tools

PWA 106201 - Compressor, Mechanical - Pliers and Wedge:
- Fan blade lock ring.

Precautions

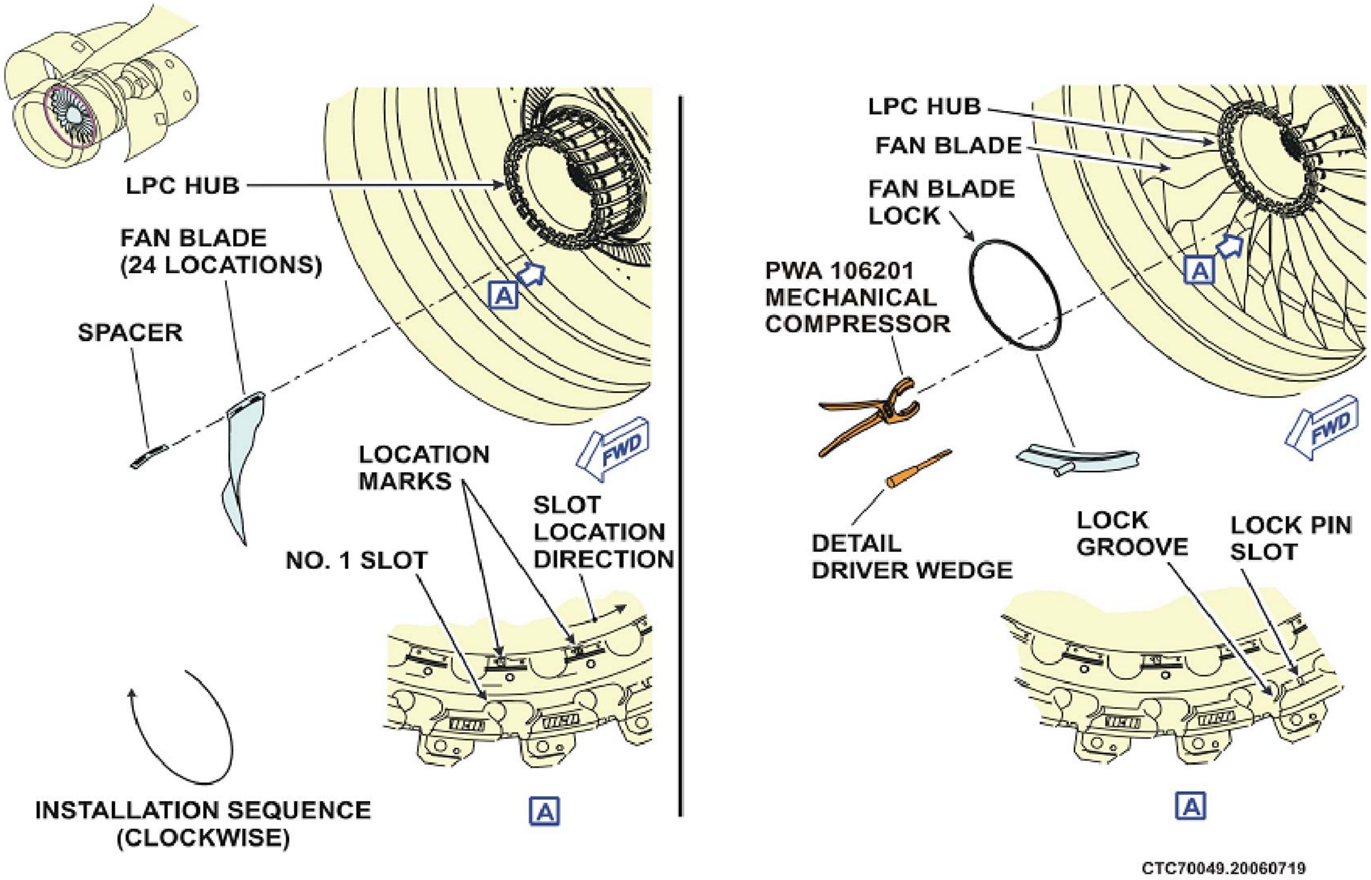
WARNING: BE CAREFUL WHEN YOU WORK ON THE ENGINE AFTER SHUTDOWN. THE ENGINE AND ENGINE OIL CAN STAY HOT FOR A LONG TIME. IF YOU DO NOT OBEY THIS WARNING, INJURY CAN OCCUR.
WARNING: REFER TO THE MSDS FOR ALL MATERIAL USED AND THE MANUFACTURER'S SAFETY INSTRUCTIONS FOR ALL EQUIPMENT USED. IF YOU DO NOT OBEY THIS WARNING, INJURY CAN OCCUR.
WARNING: USE GLOVES TO PREVENT POSSIBLE INJURY TO THE HANDS WHEN YOU HOLD THE FAN BLADES. THE BLADE EDGES ARE SHARP. IF YOU DO NOT, YOU CAN CUT YOUR HANDS.
CAUTION: INSTALL PROTECTION COVERS ON ALL OPENINGS IMMEDIATELY TO PREVENT DAMAGE TO THE ENGINE.

Prerequisite Tasks

Remove the inlet cone,
Remove the fan fairings.

Key Steps

Remove the fan blades from the storage cart,
Put the 24 blades and spacers in the position sequence that agrees with the blade sequence chart provided by the computerized balance procedure or as marked at disassembly,
Number the blades and the corresponding hub position,
Install the 24 blades and spacers,
Install the fan blade lock,
Install the fan blade fairings,
Remove the protective covers and the protective mat(s),
Perform required tests.


LPC HUB
FAN BLADE
(24 LOCATIONS)
SPACER
A
FWD
LOCATION
MARKS
SLOT
LOCATION
DIRECTION
NO. 1 SLOT
INSTALLATION SEQUENCE
(CLOCKWISE)
A
LPC HUB
FAN BLADE
FAN BLADE
LOCK
PWA 106201
MECHANICAL
COMPRESSOR
A
FWD
DETAIL
DRIVER WEDGE
LOCK
GROOVE
LOCK PIN
SLOT
A
CTC70049.20060719

FAN BLADE INSTALLATION

FAN BLADE INSTALLATION - TASK ... KEY STEPS

NACELLE & ENGINE MAINTENANCE (EA) (3)

Inlet Cone Removal

Task

Remove inlet cone.

Standard Tools

Protective Mat,
Protective Covers.

Special Tools

PWA 106417 - Puller, Knocker:
- Inlet cone

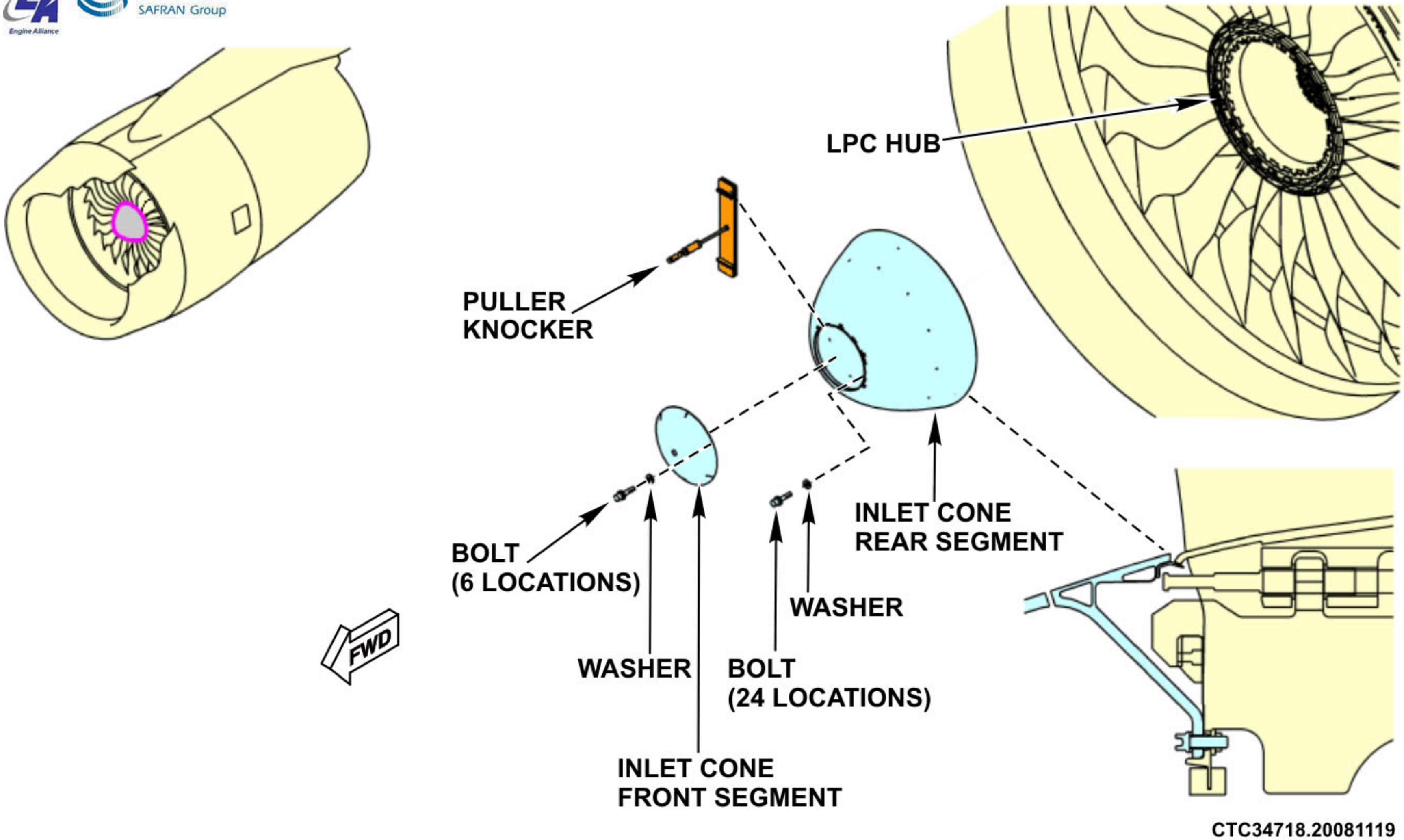
Precautions

Prerequisite Tasks

None

Key Steps

Install protective mat inside the engine intake cowl and fan case,
Install protective covers on all openings as required,
Remove the bolts and washers,
Remove inlet cone front segment,
Make alignment mark inside of the rear inlet cone segment and fan hub,
Remove bolts and washer of the rear inlet cone segment,
Remove rear inlet cone segment.


LPC HUB
PULLER KNOCKER
BOLT (6 LOCATIONS)
WASHER
INLET CONE FRONT SEGMENT
BOLT (24 LOCATIONS)
WASHER
INLET CONE REAR SEGMENT
FWD
CTC34718.20081119

INLET CONE REMOVAL/INSTALLATION

INLET CONE REMOVAL - TASK ... KEY STEPS

NACELLE & ENGINE MAINTENANCE (EA) (3)

Inlet Cone Installation

Task

Install inlet cone.

Standard Tools

Protective Mat,
Protective Covers,
Torque wrench.

Special Tools

None.

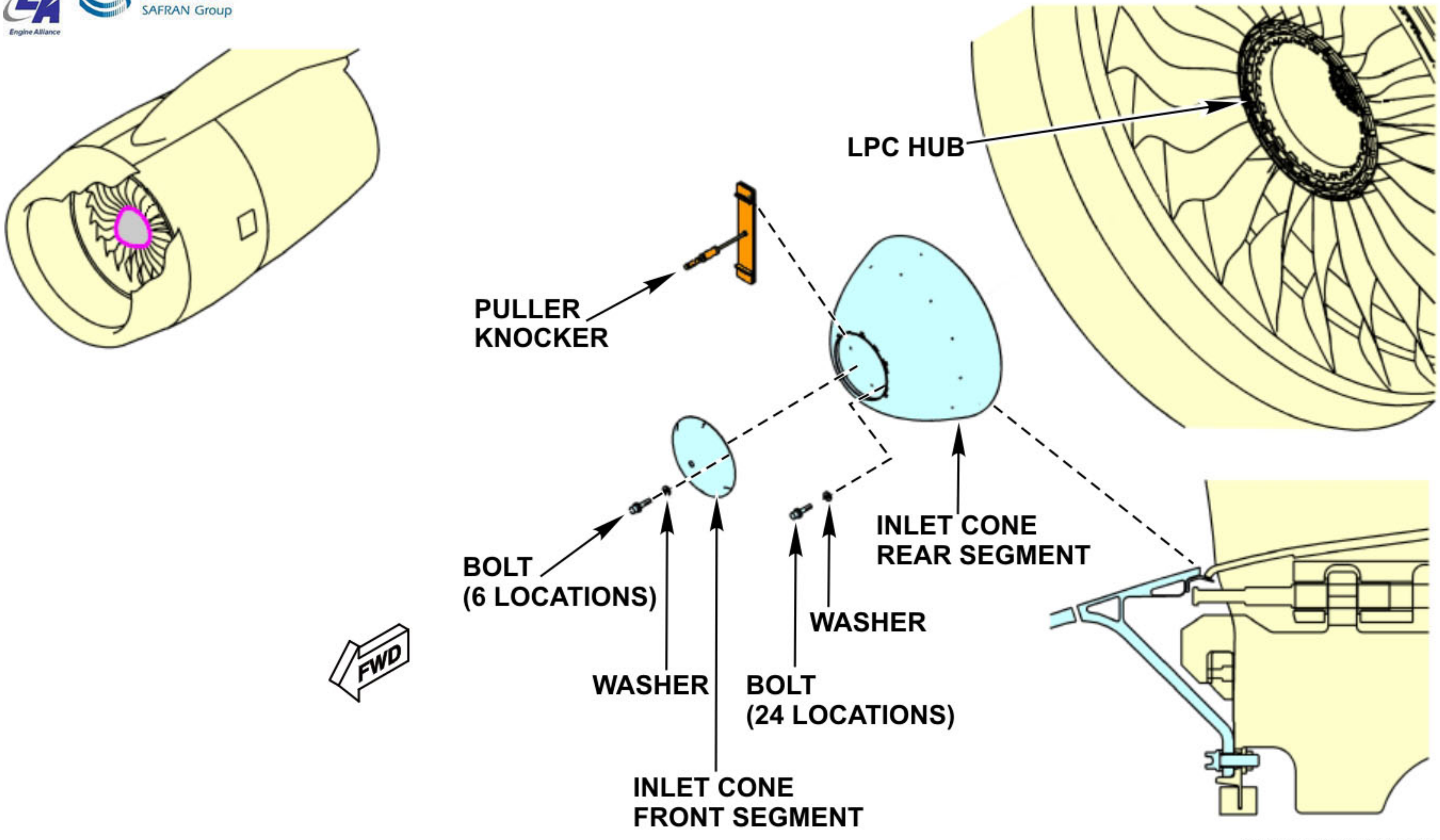
Precautions

Prerequisite Tasks

None.

Key Steps

Install protective mat inside the engine intake cowl and fan case,
Remove protective covers as necessary,
Install inlet cone rear segment to fan hub using alignment marks,
Attach bolts and washers,
Torque bolts,
Install inlet cone front segment,
Attach bolts and washers,
Torque bolts,
Remove protective mat from engine inlet.


LPC HUB
PULLER KNOCKER
INLET CONE REAR SEGMENT
BOLT (6 LOCATIONS)
WASHER
WASHER
BOLT (24 LOCATIONS)
INLET CONE FRONT SEGMENT
FWD
CTC34718.20081119

INLET CONE REMOVAL/INSTALLATION

INLET CONE INSTALLATION - TASK ... KEY STEPS

NACELLE & ENGINE MAINTENANCE (EA) (3)

Fan Blade Fairing Removal

Task

Remove fan blade fairings.

Standard Tools

Protective Mat,
Protective Covers.

Special Tools

PWA 105716 - Puller, Knocker:
- Fairing lock pin.

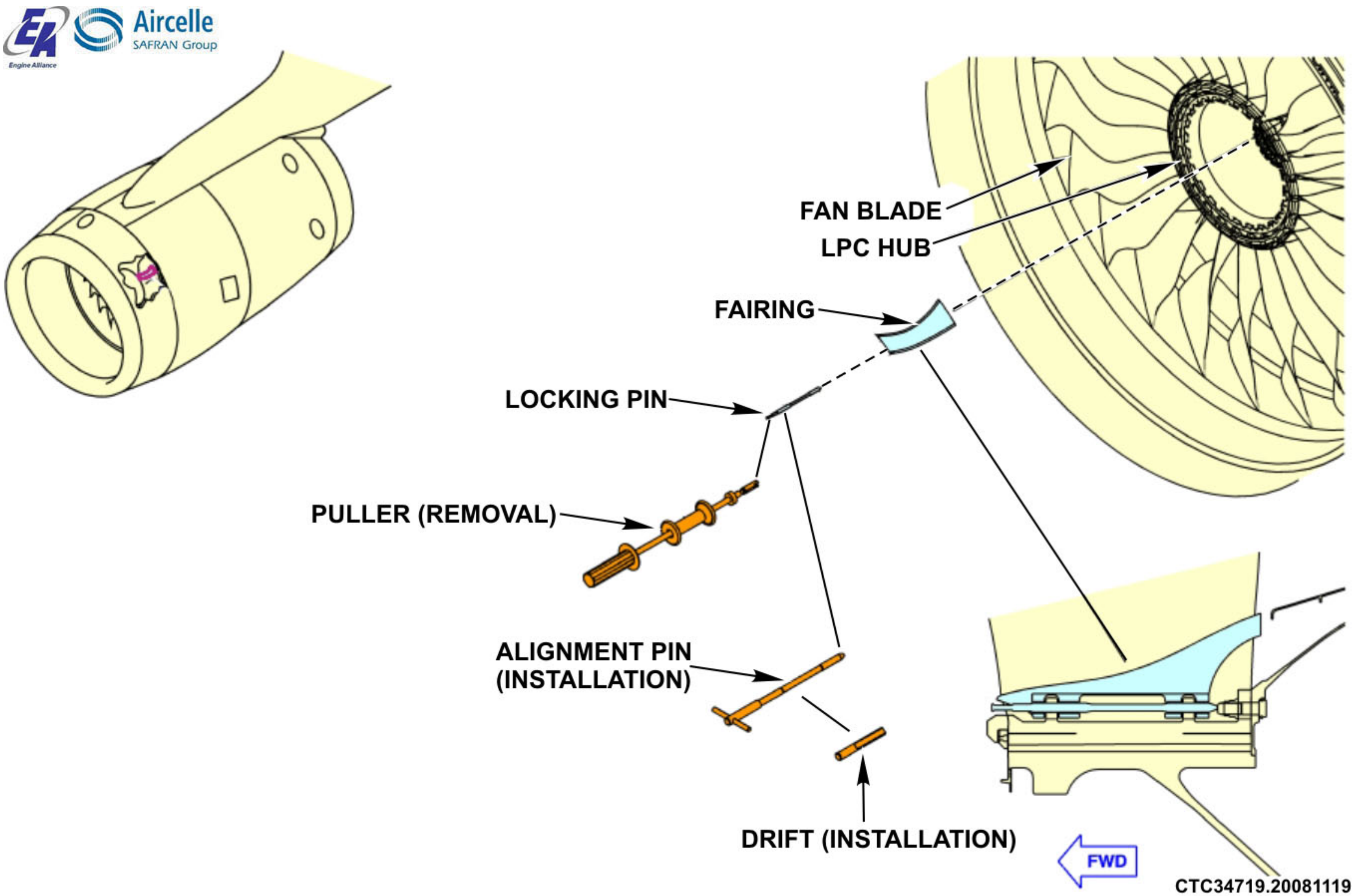
Precautions

Prerequisite Tasks

Remove the inlet cone front segment,
Remove the inlet cone rear segment

Key Steps

Install protective mat inside the engine intake cowl and fan case,
Install protective covers on all openings as required,
Remove inlet cone,
Mark location of each fan blade fairing (1-24),
Move pin at each fairing forward, but do not remove,
Remove 24 fan blade fairings from between the fan blades.


FAN BLADE
LPC HUB
FAIRING
LOCKING PIN
PULLER (REMOVAL)
ALIGNMENT PIN
(INSTALLATION)
DRIFT (INSTALLATION)
FWD
CTC34719.20081119

FAN BLADE FAIRING REMOVAL/INSTALLATION

FAN BLADE FAIRING REMOVAL - TASK ... KEY STEPS

NACELLE & ENGINE MAINTENANCE (EA) (3)

Fan Blade Fairing Installation

Task

Install fan blade fairings.

Standard Tools

Protective Mat,
Protective Covers.

Special Tools

PWA 102275 - Drift
- Fairing pin.
PWA 105714 - Pin, Alignment
- Fairing

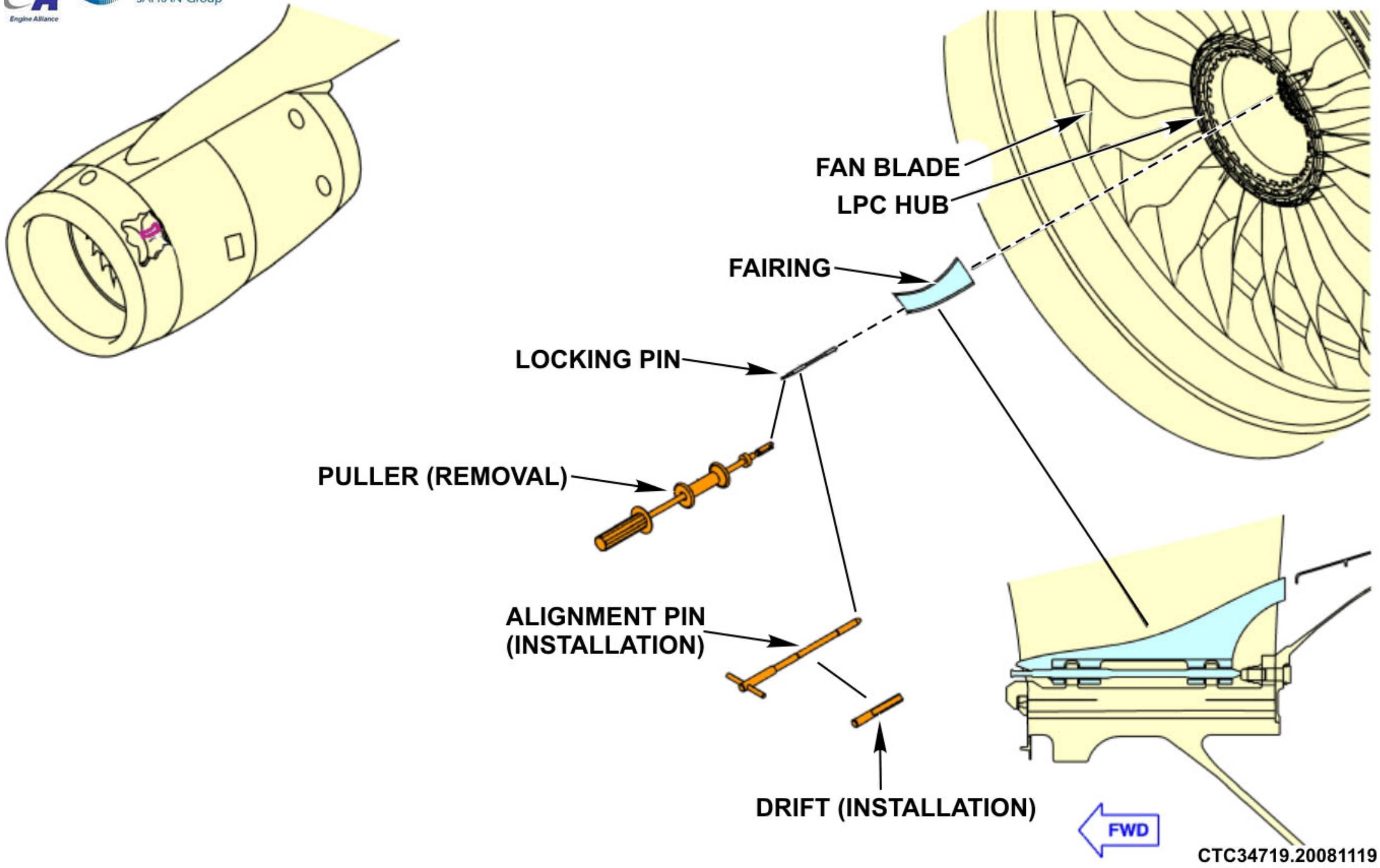
Precautions

Prerequisite Tasks

Remove the inlet cone front segment,
Remove the inlet cone rear segment

Key Steps

Install protective mat inside the engine intake cowl and fan case,
Remove protective covers as required,
Install each of the 24 fan blade fairings using the mark on each fairing,
Examine all lock pins to make sure they are all engaged and pin heads are installed forward,
Install the inlet cone
Remove the protective mat


FAN BLADE
LPC HUB
FAIRING
LOCKING PIN
PULLER (REMOVAL)
ALIGNMENT PIN (INSTALLATION)
DRIFT (INSTALLATION)
FWD
CTC34719.20081119

FAN BLADE FAIRING REMOVAL/INSTALLATION

FAN BLADE FAIRING INSTALLATION - TASK ... KEY STEPS

FUEL DISTRIBUTION SYSTEM DESCRIPTION (EA) (3)

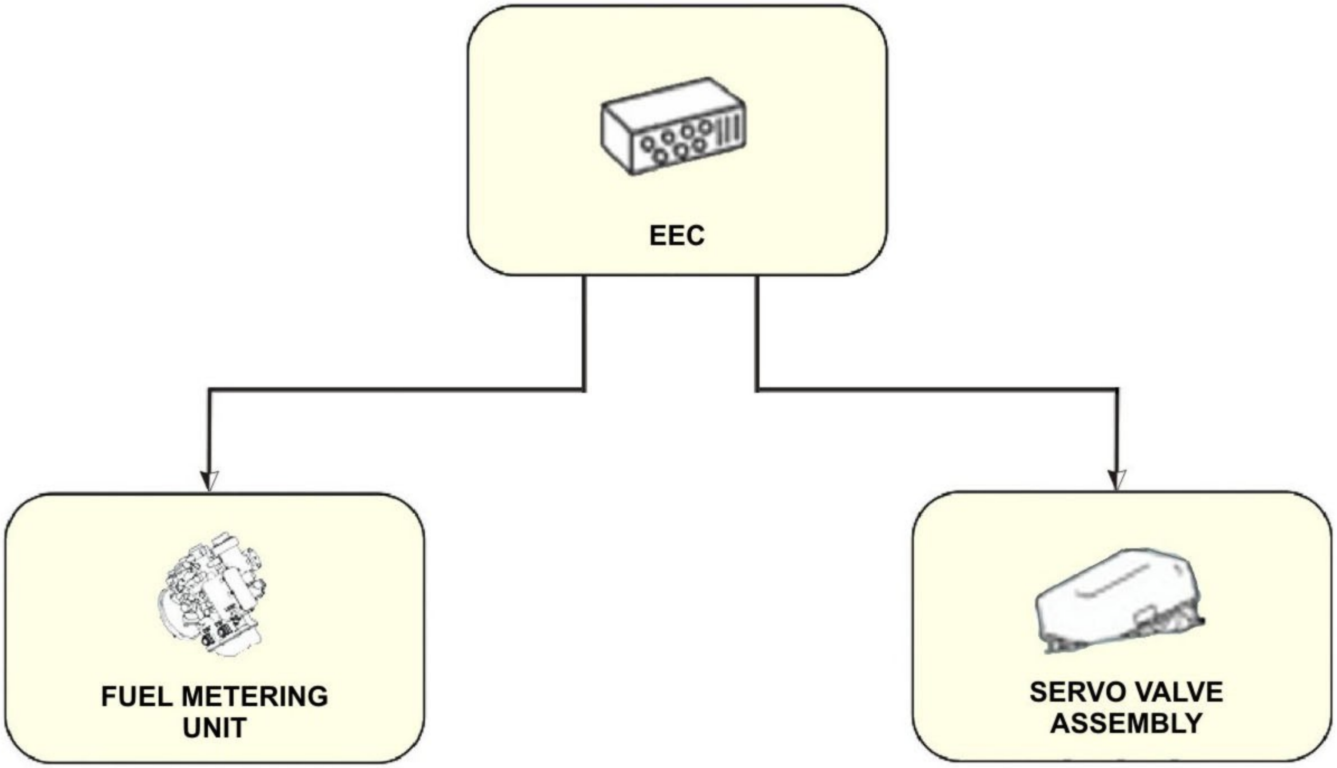
General Overview

Purpose

The fuel distribution system supplies metered fuel to the fuel nozzles to support combustion for all operating conditions.
It supplies servo fuel pressure to operate engine actuators and valves.
It cools the engine oil.

Description and Operation

The Electronic Engine Control (EEC) controls the Fuel Metering Unit (FMU) and the Servo Valve Assembly (SVA).


EEC
FUEL METERING UNIT
SERVO VALVE ASSEMBLY

CTC70052.20070104

GENERAL OVERVIEW - PURPOSE & DESCRIPTION AND OPERATION

FUEL DISTRIBUTION SYSTEM DESCRIPTION (EA) (3)

Supply, Pressure and Servo

Purpose

Supply ice-free, filtered fuel at the pressures and flow rates necessary for combustion to meet all engine operating requirements.
Supply servo fuel pressure to operate engine actuators and valves.
Cool the engine oil.

Components

Main fuel supply line:
- Located between 12 o'clock and 5 o'clock, at the rear of the combustor diffuser case between K and M flanges.

Fuel Pump (FP):
- Mounted on the rear of the main gearbox at 5 o'clock.

Fuel strainer
- Located in the fuel pump

Fuel filter assembly:
- Mounted on the fuel pump.

Main fuel/oil heat exchanger:
- Located on the high compressor case at 3 o'clock.

Fuel Metering Unit (FMU):
- Mounted on the rear of the main gearbox at 4 o'clock.

Fuel Flow Transmitter (FFT):
- Bracket mounted to the main gearbox at 3 o'clock.

Fuel manifolds:
- Located around the combustor diffuser case.

Fuel nozzles:
- Located around the combustor diffuser case.

Servo Valve Assembly (SVA):
- Located on the high pressure compressor front case at 12 o'clock.

Servo fuel heater:
- Mounted on the main gearbox, inboard of the fuel flow transmitter, at 3 o'clock.

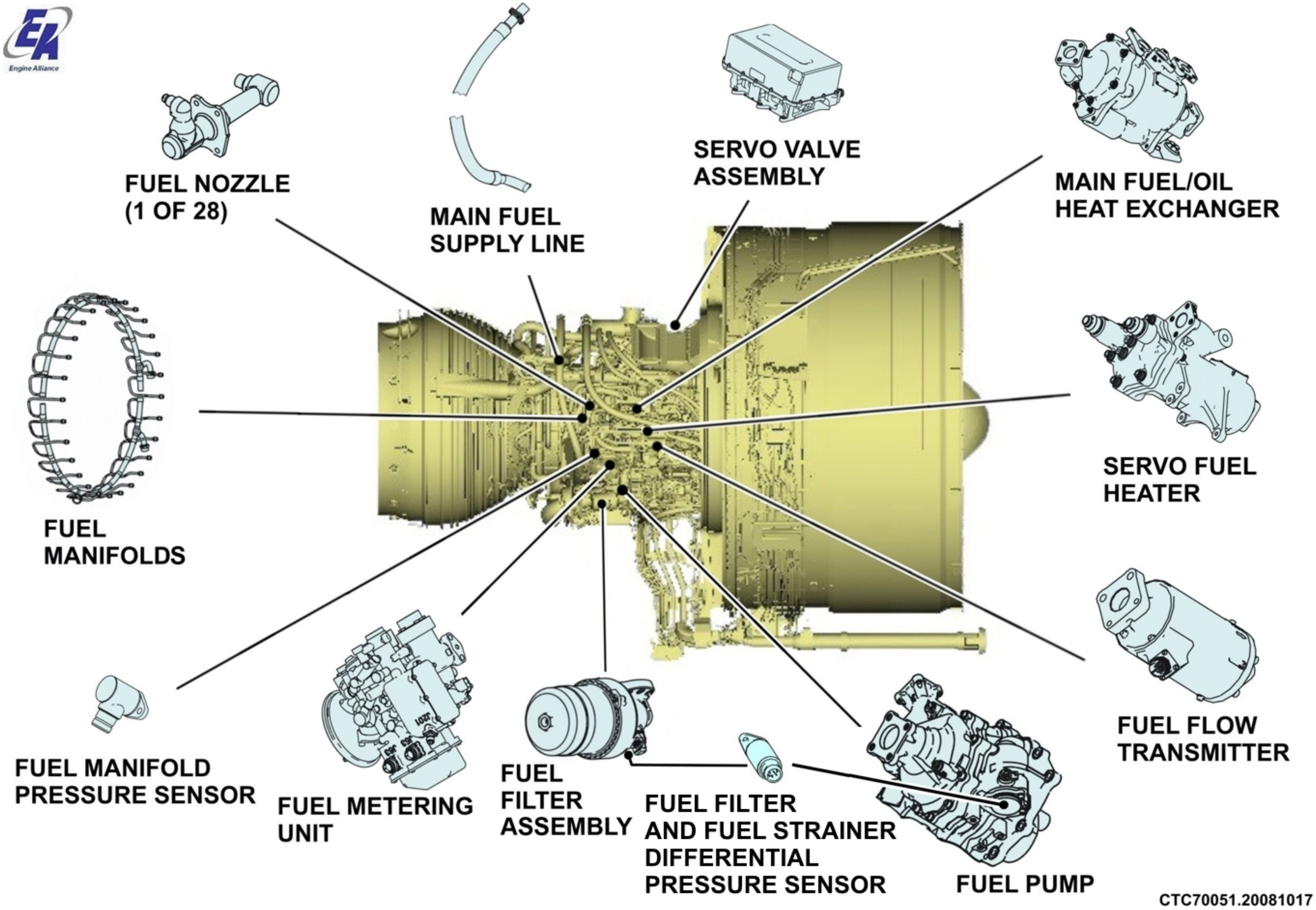
Fuel manifold pressure sensor:
- Located on the FMU.

Fuel filter differential pressure sensor:
- Located on the fuel filter assembly.

Fuel strainer differential pressure sensor
- Located on the main fuel pump strainer cover

LRUs

Main fuel supply line,
Fuel pump,
Fuel strainer,
Fuel filter element,
Fuel filter assembly,
Fuel metering unit,
Fuel flow transmitter,
Fuel nozzles,
Main fuel/oil heat exchanger,
Servo valve assembly,
Servo fuel heater,
Fuel manifold pressure sensor,
Fuel filter differential pressure sensor,
Fuel strainer differential pressure sensor.


FUEL NOZZLE
(1 OF 28)
MAIN FUEL
SUPPLY LINE
SERVO VALVE
ASSEMBLY
MAIN FUEL/OIL
HEAT EXCHANGER
FUEL
MANIFOLDS
SERVO FUEL
HEATER
FUEL FLOW
TRANSMITTER
FUEL MANIFOLD
PRESSURE SENSOR
FUEL METERING
UNIT
FUEL
FILTER
ASSEMBLY
FUEL FILTER
AND FUEL STRAINER
DIFFERENTIAL
PRESSURE SENSOR
FUEL PUMP
CTC70051.20081017

SUPPLY, PRESSURE AND SERVO - PURPOSE ... LRUS

FUEL DISTRIBUTION SYSTEM DESCRIPTION (EA) (3)

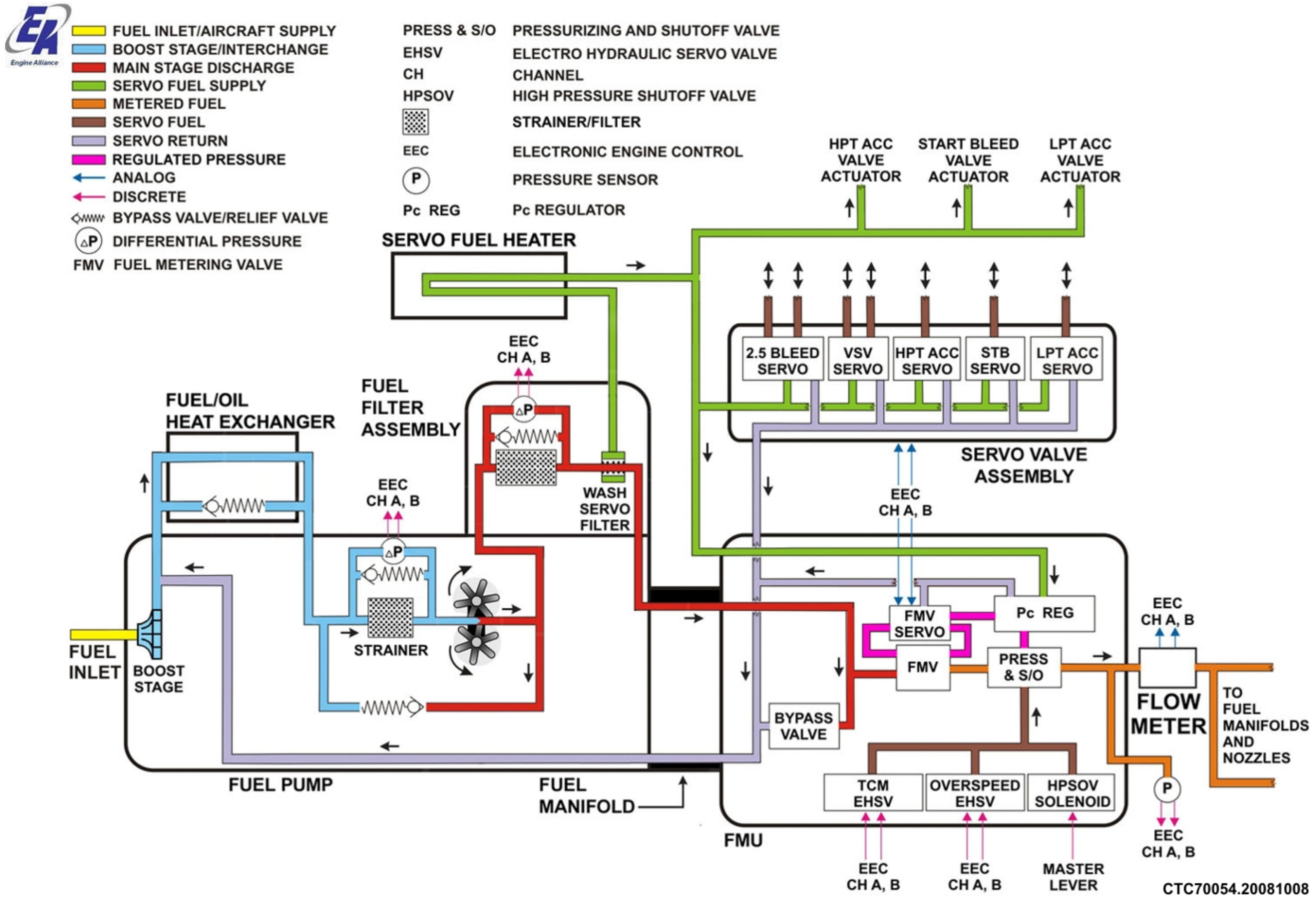
Supply, Pressure and Servo (continued)

Description and Operation

Aircraft fuel flows through the main fuel supply line to the Fuel Pump (FP) boost stage inlet port.
The FP boost stage increases the fuel pressure and sends it to the main fuel/oil heat exchanger.
The main fuel/oil heat exchanger heats the fuel and sends it to the FP gear stage.
The heated fuel flows across a fuel strainer before entering the FP gear stage.
The FP gear stage increases the fuel pressure and sends the high-pressure fuel to the fuel filter assembly.
A high pressure relief valve on the discharge side of the gear stage will open at high discharge pressures to prevent excessive fuel pressure.
The excess fuel is returned to the inlet side of the gear stage.
The majority of the high-pressure filtered fuel is sent to the Fuel Metering Unit (FMU), but a small amount of the fuel flows across a wash servo filter and is sent to the servo fuel heater.
The heated servo fuel is sent to the Servo Valve Assembly (SVA), the High Pressure Turbine Active Clearance Control (HPT ACC) valve actuator, the start bleed valve actuator, the Low Pressure Turbine Active Clearance Control (LPT ACC) valve actuator, and the FMU fuel metering valve servo valve and FMU Pc regulator.
The SVA distributes servo fuel to the:

- 2.5 bleed valve actuator,
- Variable Stator Vane (VSV) actuators,
- HPT ACC valve actuator,
- Start bleed valve,
- LPT ACC valve actuator.

The filtered fuel that is sent to the FMU flows across the fuel metering valve. The EEC controls the metering valve position.
The metered fuel flows to the pressure and shutoff valve.
The pressure and shutoff valve is commanded OPEN or CLOSED by the Master Lever and the EEC. When it is commanded OPEN metered fuel will flow from the FMU through the fuel flow transmitter.
The fuel flow transmitter (meter) sends fuel flow indication to the EEC.
The metered fuel then flows through the fuel manifolds to the twenty-eight fuel nozzles where it is atomized for combustion.
The EEC receives inputs from the fuel strainer delta pressure sensor, the fuel filter delta pressure sensor, and the fuel manifold pressure sensor.


Engine Alliance
FUEL INLET/AIRCRAFT SUPPLY
BOOST STAGE/INTERCHANGE
MAIN STAGE DISCHARGE
SERVO FUEL SUPPLY
METERED FUEL
SERVO FUEL
SERVO RETURN
REGULATED PRESSURE
ANALOG
DISCRETE
BYPASS VALVE/RELIEF VALVE
DIFFERENTIAL PRESSURE
FMV FUEL METERING VALVE
PRESS & S/O PRESSURIZING AND SHUTOFF VALVE
EHSV ELECTRO HYDRAULIC SERVO VALVE
CH CHANNEL
HPSOV HIGH PRESSURE SHUTOFF VALVE
STRAINER/FILTER
EEC ELECTRONIC ENGINE CONTROL
P PRESSURE SENSOR
Pc REG Pc REGULATOR
SERVO FUEL HEATER
HPT ACC VALVE ACTUATOR
START BLEED VALVE ACTUATOR
LPT ACC VALVE ACTUATOR
2.5 BLEED SERVO
VSV SERVO
HPT ACC SERVO
STB SERVO
LPT ACC SERVO
SERVO VALVE ASSEMBLY
EEC CH A, B
FUEL FILTER ASSEMBLY
FUEL/OIL HEAT EXCHANGER
WASH SERVO FILTER
STRAINER
FUEL INLET
BOOST STAGE
FUEL PUMP
FUEL MANIFOLD
FMU
FMV SERVO
Pc REG
FMV
PRESS & S/O
BYPASS VALVE
TCM EHSV
OVERSPEED EHSV
HPSOV SOLENOID
MASTER LEVER
FLOW METER
TO FUEL MANIFOLDS AND NOZZLES
P
CTC70054.20081008

SUPPLY, PRESSURE AND SERVO - DESCRIPTION AND OPERATION

COMPRESSOR AIRFLOW CONTROL (EA) (3)

General Overview

Purpose

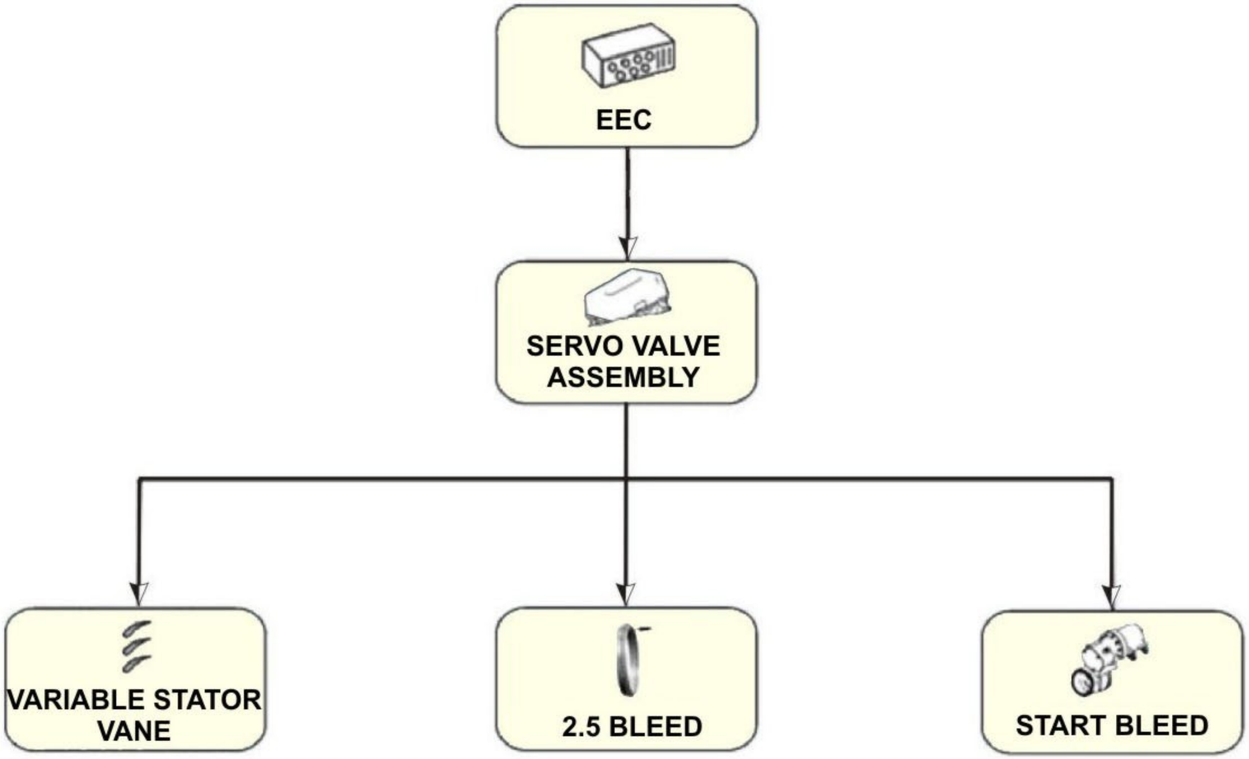
The compressor control system provides optimum performance and increased compressor stability during engine starting, steady state, transient, and reverse thrust operations.

Subsystems

Variable stator vane,
2.5 bleed,
Start bleed.

Description

The compressor control system uses four stages of variable vanes and two bleed valves to provide engine efficiency and stability.
The compressor control subsystems are independent and are controlled by the EEC.


EEC
SERVO VALVE ASSEMBLY
VARIABLE STATOR VANE
2.5 BLEED
START BLEED

CTC70025.20070103

GENERAL OVERVIEW - PURPOSE ... DESCRIPTION

COMPRESSOR AIRFLOW CONTROL (EA) (3)

Variable Stator Vane

Purpose

The variable stator vane system controls the amount of airflow through the High Pressure Compressor (HPC) to provide optimum engine performance at steady state conditions, and prevent compressor stall during engine transient operation.

Components

Inlet Guide Vanes (IGVs):
- Mounted to the rear of the fan hub frame.

1st , 2nd and 3rd Variable Stator Vane (VSV) stages:
- Mounted to the front of the HPC case.

Variable stator vane actuators (2):
- Attached to the HPC case at 2 o'clock and at 7 o'clock.

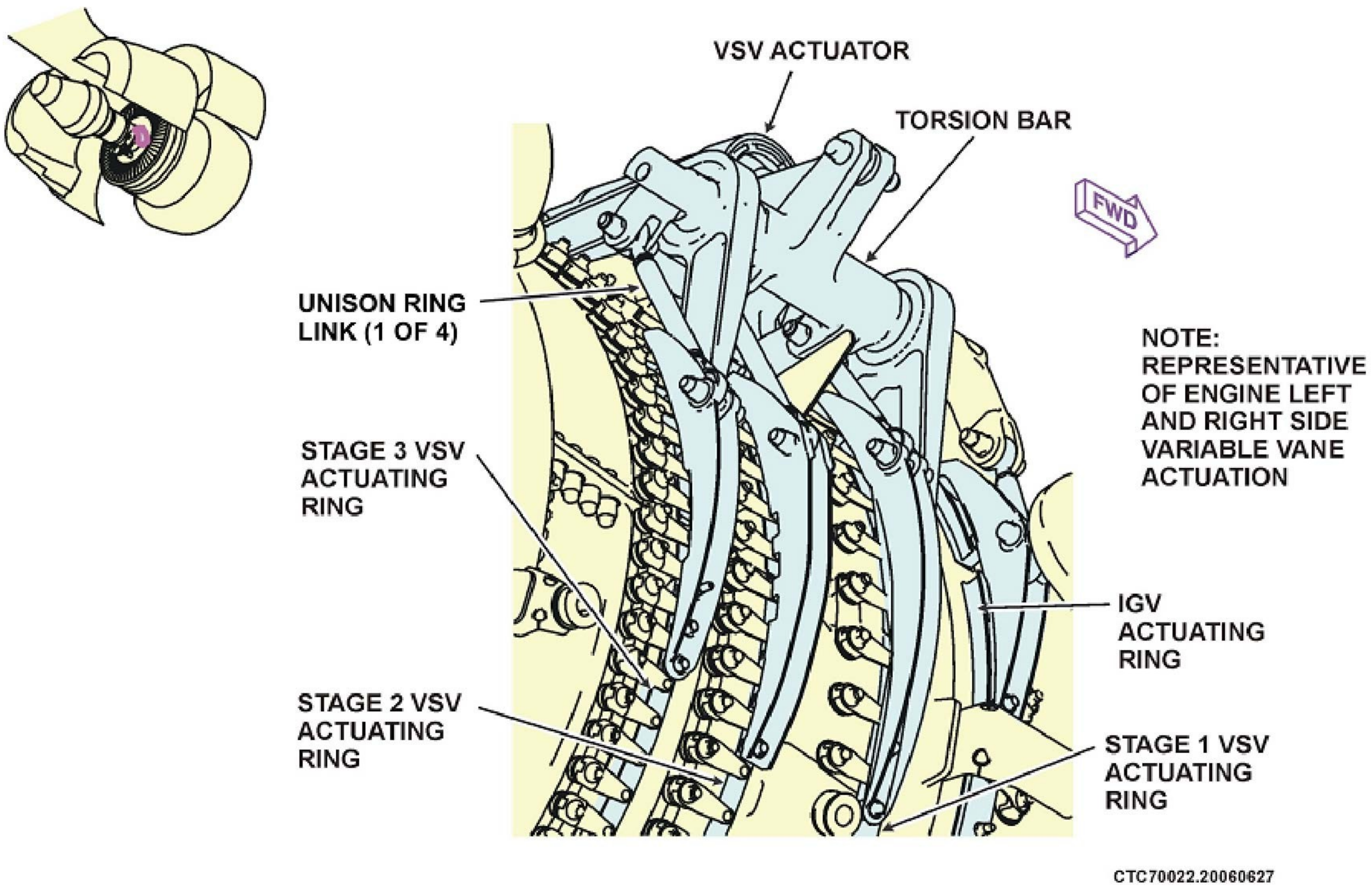
Description and Operation

The two VSV actuators supply the force to position the variable stator vanes:
- As the VSV actuator rods move, they position the torsion bars, the unison ring links, the unison rings, and the variable stator vanes.

At low engine rpm, the variable vanes are moved toward the closed position to reduce airflow through the HPC.
At high engine rpm, the variable vanes are moved toward the open position to increase airflow through the HPC.

LRUs

Stator vane actuators.


VSV ACTUATOR
TORSION BAR
FWD
UNISON RING LINK (1 OF 4)
NOTE: REPRESENTATIVE OF ENGINE LEFT AND RIGHT SIDE VARIABLE VANE ACTUATION
STAGE 3 VSV ACTUATING RING
IGV ACTUATING RING
STAGE 2 VSV ACTUATING RING
STAGE 1 VSV ACTUATING RING
CTC70022.20060627

VARIABLE STATOR VANE - PURPOSE ... LRUS

LB408521 - L5CT0T0 - LM7E9A000000001

COMPRESSOR AIRFLOW CONTROL (EA) (3)

Variable Stator Vane (continued)

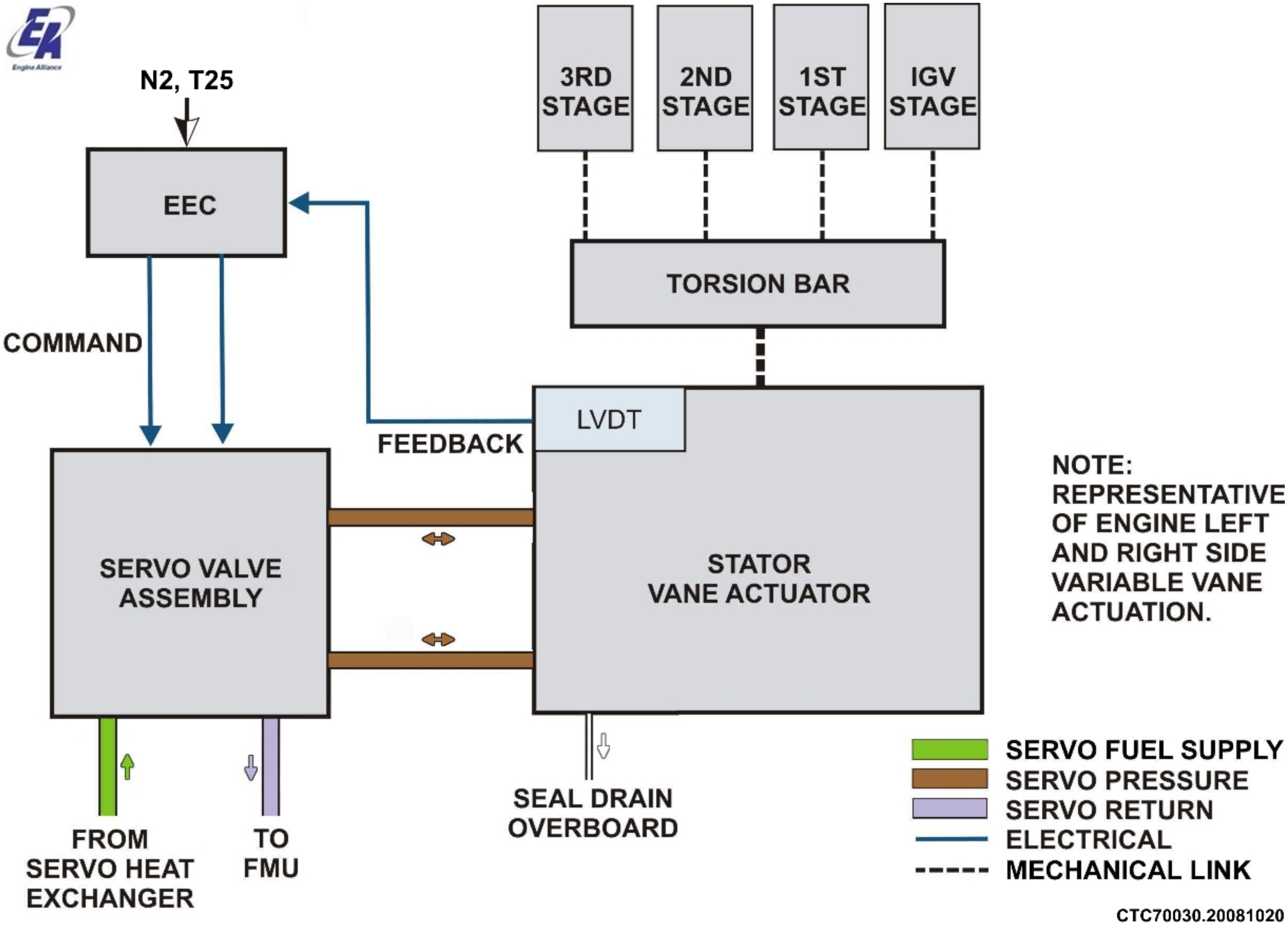
Description and Operation (Continued)

The Electronic Engine Control (EEC) determines the required VSV position based on N2 and T25 inputs:

- The EEC sends an electrical signal to the Servo Valve Assembly (SVA) which supplies servo fuel to position both VSV actuators.
- If there is no EEC control, the vanes failsafe position is closed.

A single LVDT in each actuator provides feedback to the EEC:

- The 2 o'clock actuator provides the feedback to Channel A,
- The 7 o'clock actuator provides the feedback to Channel B.


N2, T25
EEC
COMMAND
FEEDBACK
3RD STAGE
2ND STAGE
1ST STAGE
IGV STAGE
TORSION BAR
LVDT
SERVO VALVE ASSEMBLY
STATOR VANE ACTUATOR
FROM SERVO HEAT EXCHANGER
TO FMU
SEAL DRAIN OVERBOARD
NOTE: REPRESENTATIVE OF ENGINE LEFT AND RIGHT SIDE VARIABLE VANE ACTUATION.
SERVO FUEL SUPPLY
SERVO PRESSURE
SERVO RETURN
ELECTRICAL
MECHANICAL LINK
CTC70030.20081020

VARIABLE STATOR VANE - DESCRIPTION AND OPERATION (CONTINUED)

COMPRESSOR AIRFLOW CONTROL (EA) (3)

2.5 Bleed

Purpose

The 2.5 bleed system controls low pressure compressor 6th stage bleed airflow into the fan air stream to optimize engine performance and prevent compressor stalls.

Components

2.5 bleed valve:
- Attached to the Fan Hub Frame (FHF).

2.5 bleed valve actuator:
- Attached to the fan hub frame at 11 o'clock.

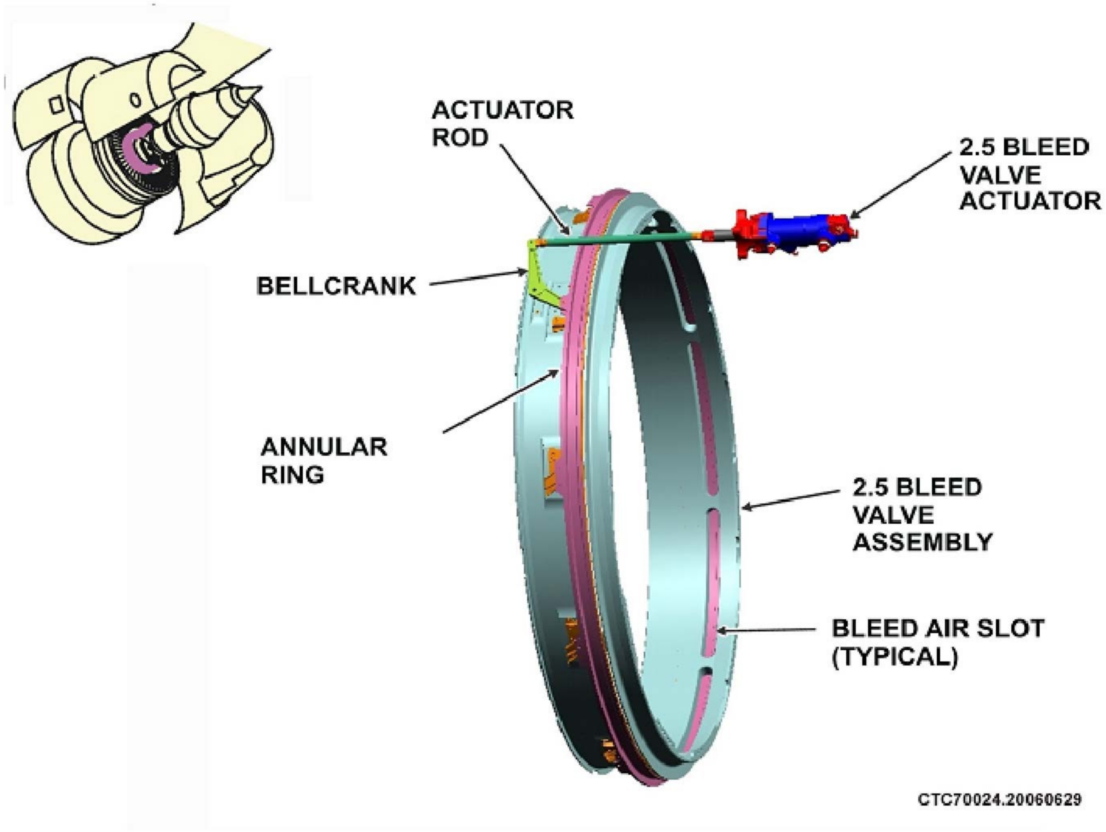
Description and Operation

When the 2.5 bleed actuator rod moves, it positions a bellcrank, a connecting link and the 2.5 bleed valve.

Movement of the 2.5 bleed valve controls the amount of 6th stage air that flows through slots in the bleed valve duct into the fan air stream.
The actuator contains a dual-channel LVDT for position feedback to the EEC.
The 2.5 bleed valve is open when the engine is shutdown, during engine start, and when the engine is operating at idle.
The 2.5 bleed valve starts to close as the engine accelerates above idle, and is completely closed at take-off power.
During descent, reverse thrust operation and low power icing conditions the 2.5 bleed valve open to increase LPC stability, and to prevent Foreign Object Damage (FOD) to the core engine.

LRUs

2.5 bleed valve actuator.


ACTUATOR ROD
2.5 BLEED VALVE ACTUATOR
BELLCRANK
ANNULAR RING
2.5 BLEED VALVE ASSEMBLY
BLEED AIR SLOT (TYPICAL)
CTC70024.20060629

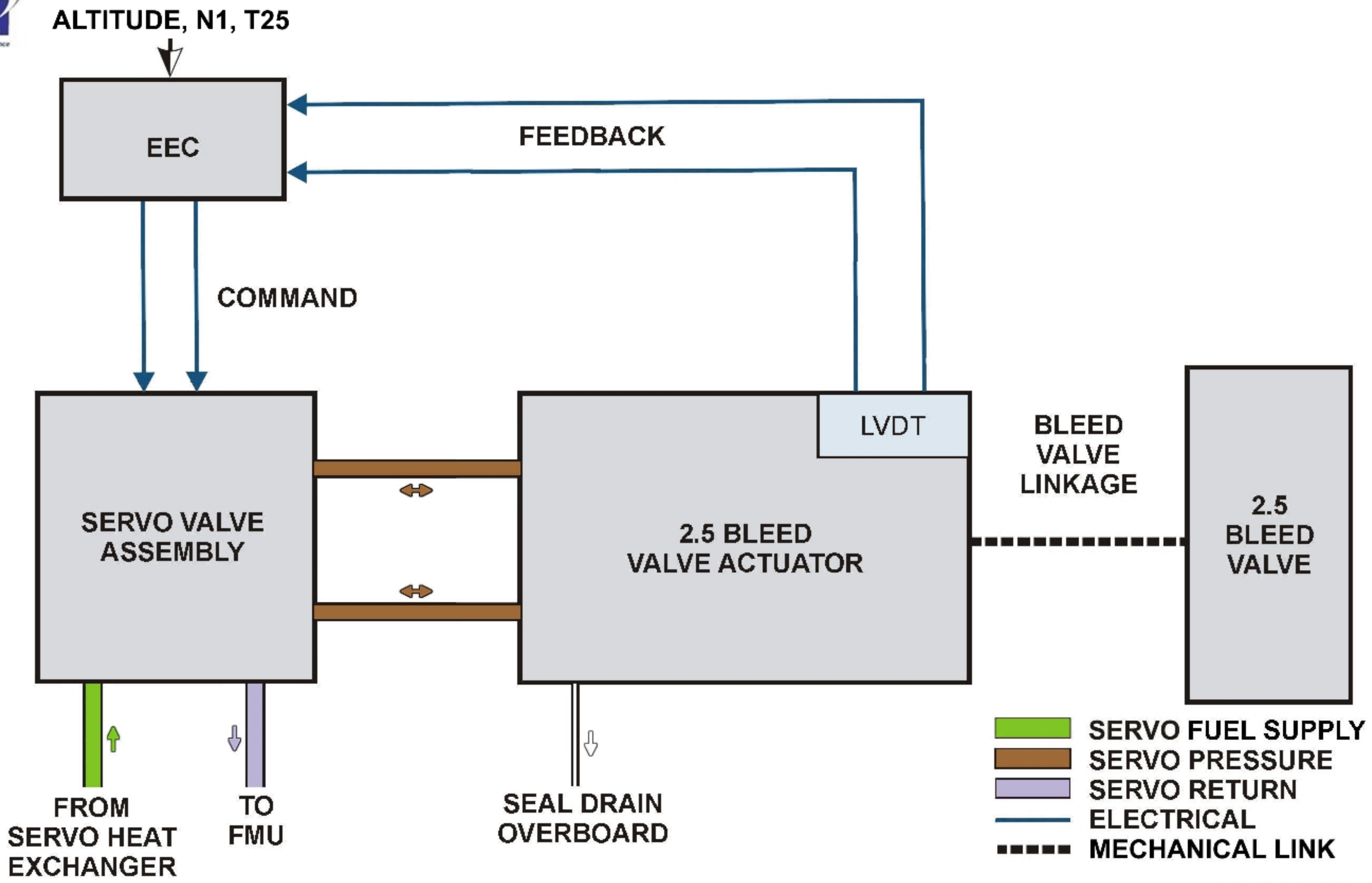
2.5 BLEED - PURPOSE ... LRUS

COMPRESSOR AIRFLOW CONTROL (EA) (3)

2.5 Bleed (continued)

Description and Operation (Continued)

The EEC determines the required 2.5 bleed valve actuator position based on sensor inputs: Altitude (P0), N1 and T2.5.
The EEC sends an electrical signal to the servo valve assembly (SVA), which controls servo fuel to the 2.5 bleed actuator, moving the 2.5 bleed valve.
If there is no EEC control, the valve failsafe position is open.
The actuator contains a dual-channel LVDT for position feedback to the EEC.


ALTITUDE, N1, T25
EEC
FEEDBACK
COMMAND
SERVO VALVE ASSEMBLY
2.5 BLEED VALVE ACTUATOR
LVDT
BLEED VALVE LINKAGE
2.5 BLEED VALVE
FROM SERVO HEAT EXCHANGER
TO FMU
SEAL DRAIN OVERBOARD
SERVO FUEL SUPPLY
SERVO PRESSURE
SERVO RETURN
ELECTRICAL
MECHANICAL LINK
CTC70029.20081020

2.5 BLEED - DESCRIPTION AND OPERATION (CONTINUED)

COMPRESSOR AIRFLOW CONTROL (EA) (3)

Start Bleed

Purpose

The start bleed system controls the flow of 7^{th} stage HPC bleed air to optimize compressor performance and prevent compressor stalls during ground or in flight engine starts.

Components

Start bleed valve (SBV):
- Attached to the air duct, aft of the fan hub frame, at 12:00 o'clock.

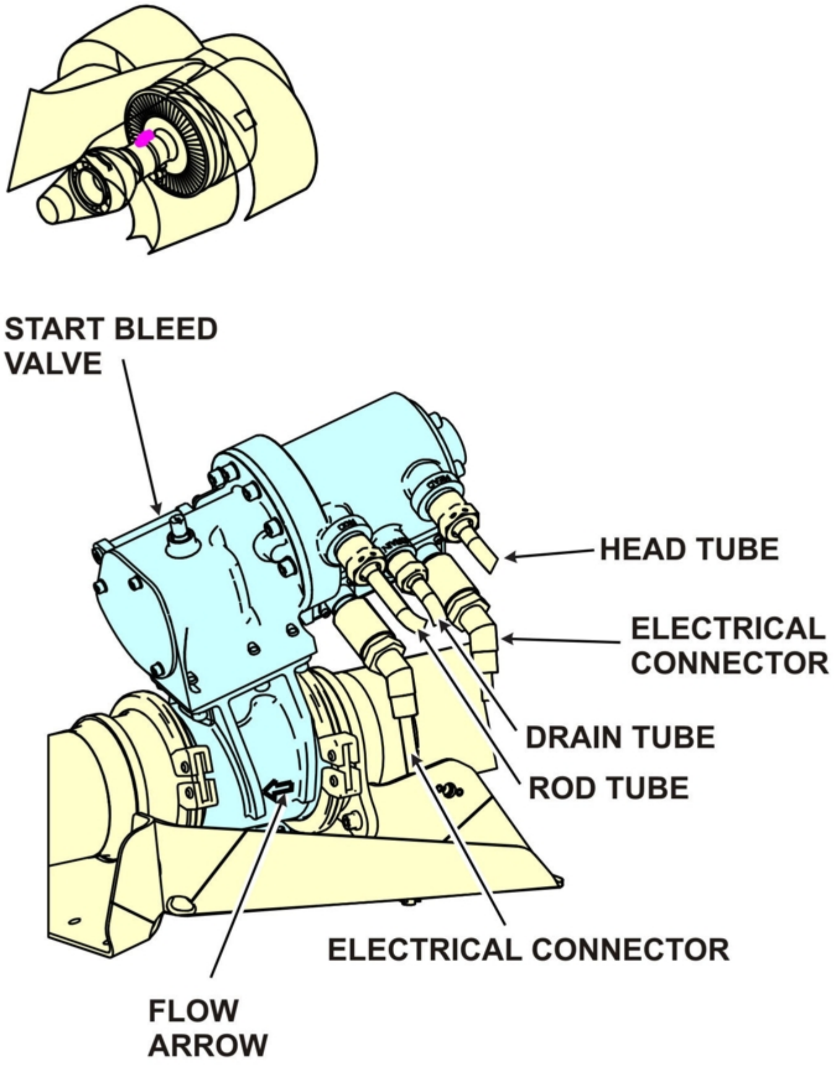
Description and Operation

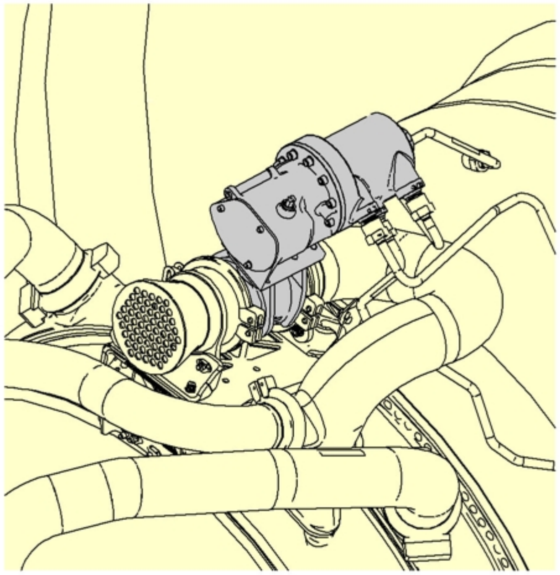
The start bleed valve is spring closed, and is opened by servo fuel pressure.

When the start bleed valve is open 7^{th} stage air is released into the core compartment.

LRUs

Start bleed valve.


START BLEED VALVE
HEAD TUBE
ELECTRICAL CONNECTOR
DRAIN TUBE
ROD TUBE
ELECTRICAL CONNECTOR
FLOW ARROW



CTC70028.20071206

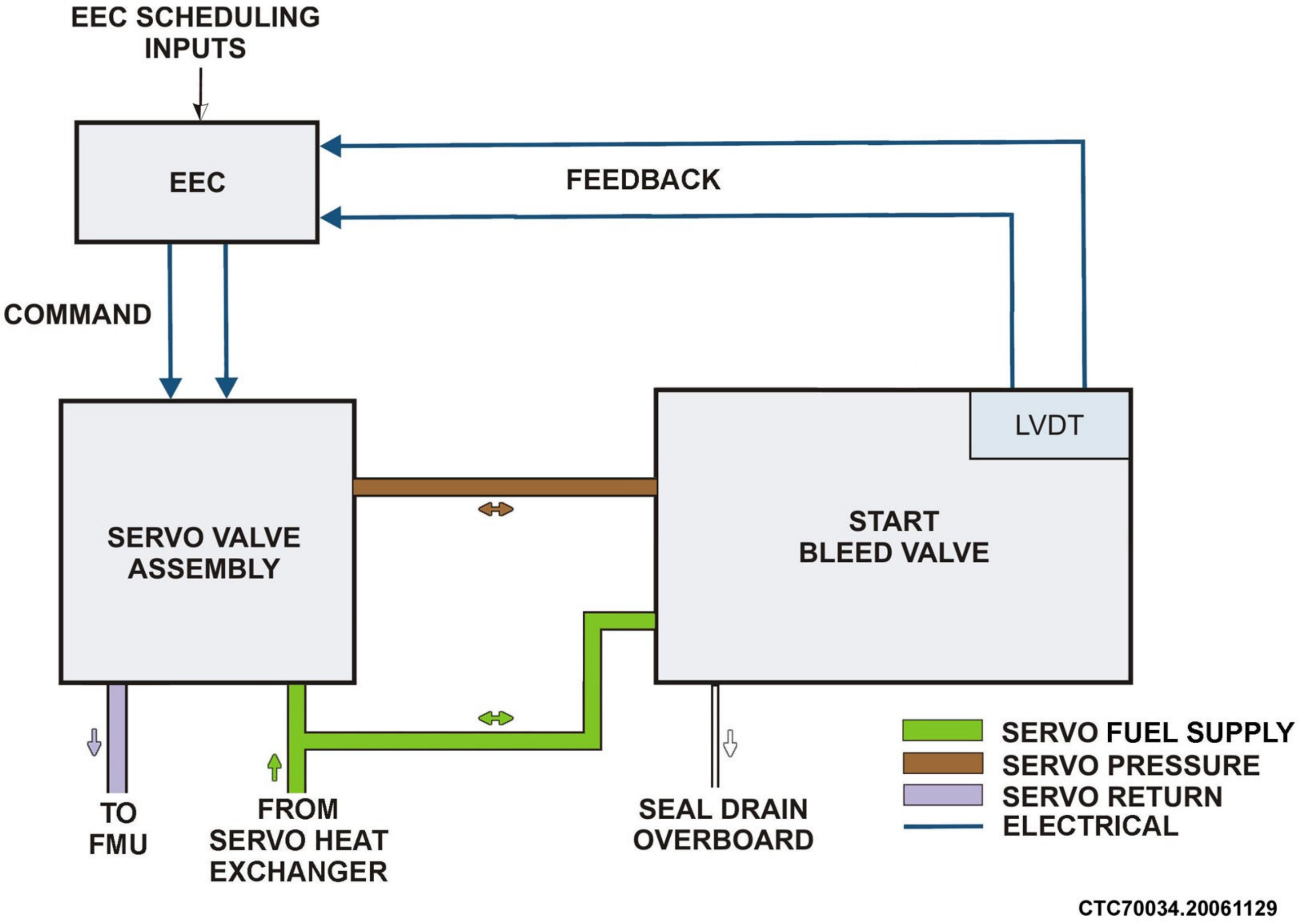
START BLEED - PURPOSE ... LRUS

COMPRESSOR AIRFLOW CONTROL (EA) (3)

Start Bleed (continued)

Description and Operation (Continued)

The EEC determines the required start bleed valve position based on aircraft and engine sensor inputs.
The EEC sends an electrical signal to the servo valve assembly (SVA), which controls the servo fuel to the start bleed valve.
If there is no EEC control, the valve failsafe position is closed.
A dual channel LVDT inside the start bleed valve provides position feedback to the EEC.


EEC SCHEDULING INPUTS
EEC
FEEDBACK
COMMAND
SERVO VALVE ASSEMBLY
LVDT
START BLEED VALVE
TO FMU
FROM SERVO HEAT EXCHANGER
SEAL DRAIN OVERBOARD
SERVO FUEL SUPPLY
SERVO PRESSURE
SERVO RETURN
ELECTRICAL
CTC70034.20061129

START BLEED - DESCRIPTION AND OPERATION (CONTINUED)

ENGINE & ACCESSORY COOLING AIR (EA) (3)

General Overview

Purpose

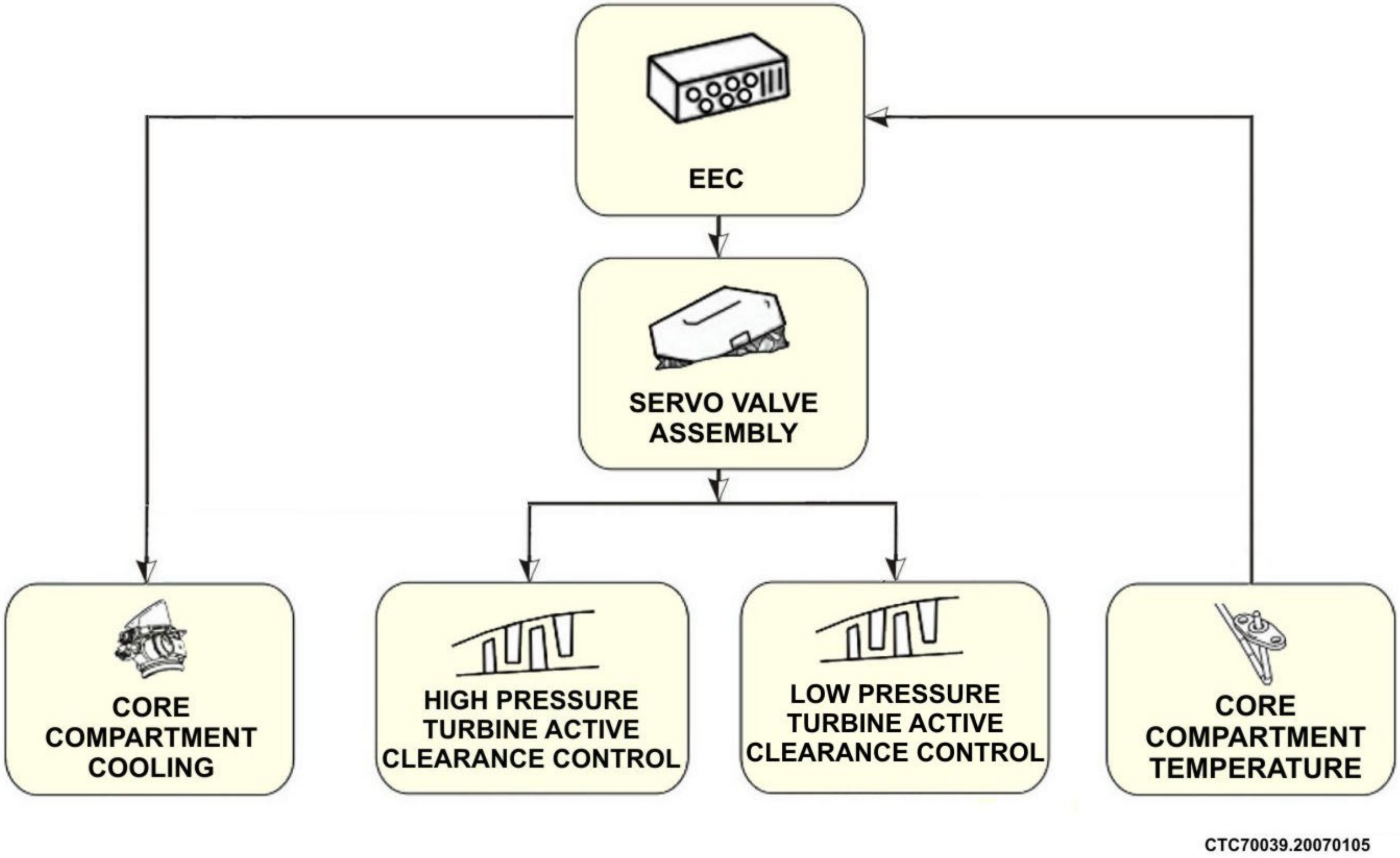
The engine and accessory cooling air system cools the turbine cases, and also cools and vents the core compartment.

Subsystems

HPT Active Clearance Control (ACC),
LPT Active Clearance Control (ACC),
Core Compartment Cooling (CCC),
Nacelle temperature sensing.

Description

The engine and accessory cooling air subsystem uses fan air to cool engine cases and components,
The cooling subsystems are independent, and are controlled by the EEC,
The core compartment temperature sensor sends nacelle temperature to the EEC.


EEC
SERVO VALVE ASSEMBLY
CORE COMPARTMENT COOLING
HIGH PRESSURE TURBINE ACTIVE CLEARANCE CONTROL
LOW PRESSURE TURBINE ACTIVE CLEARANCE CONTROL
CORE COMPARTMENT TEMPERATURE
CTC70039.20070105

GENERAL OVERVIEW - PURPOSE ... DESCRIPTION

ENGINE & ACCESSORY COOLING AIR (EA) (3)

HPT Active Clearance Control

Purpose

The HPT Active Clearance Control system (ACC) cools the high pressure turbine (HPT) case to reduce turbine blade tip clearance to improve fuel efficiency.

Components

HPT ACC inlet duct:
- Located on the rear of the Fan Hub Frame (FHF) at 10:00 o'clock.

HPT ACC air valve:
- Attached to the HPT ACC inlet duct, aft of the FHF at 10:00 o'clock.

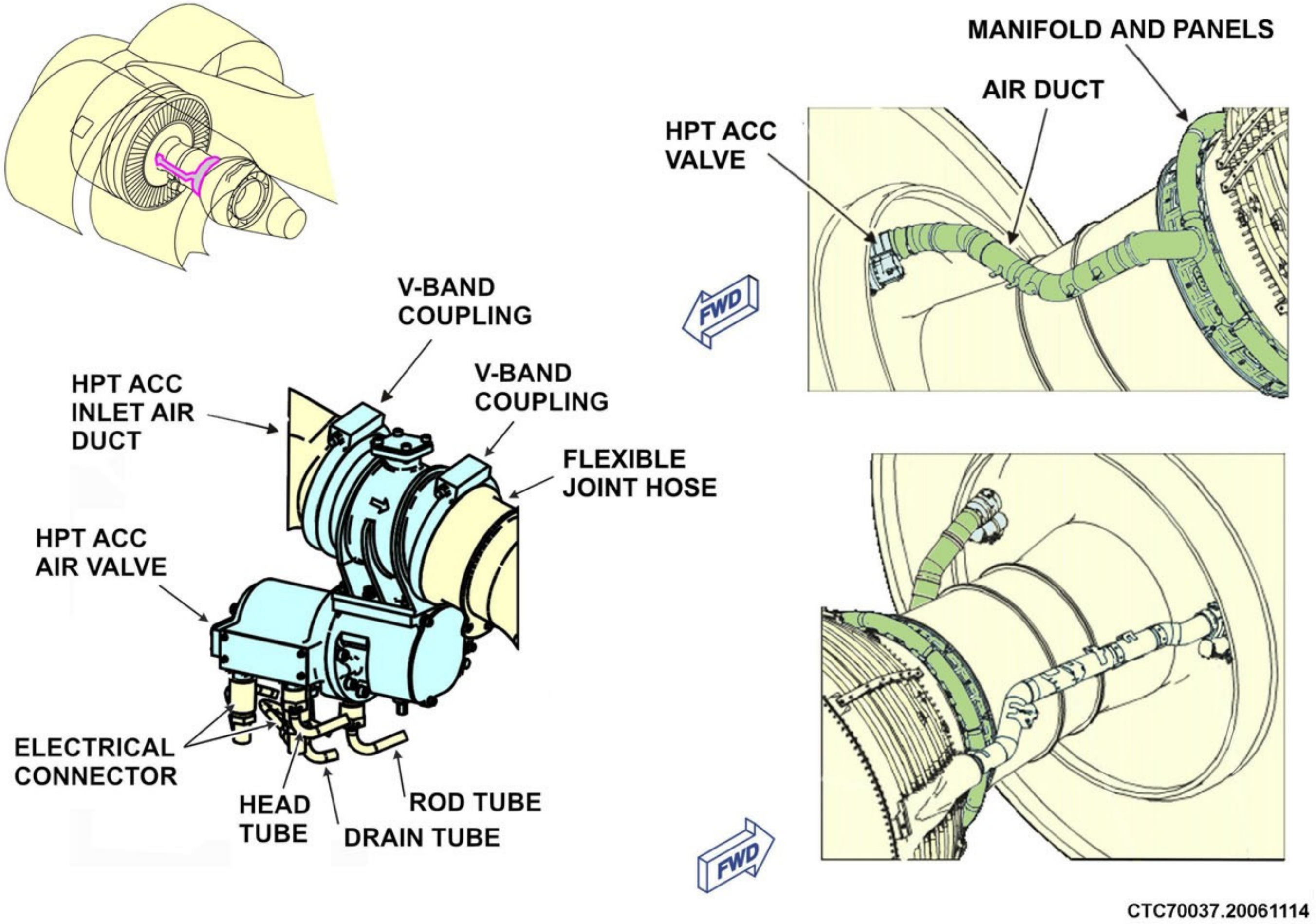
HPT ACC manifolds:
- Located circumferentially around the HPT case between M and N flanges.

Description and Operation

The HPT ACC valve controls the amount of fan air sent through the air duct to the HPT ACC manifolds and panels.
The cooling air exits from holes on the inner diameter of the manifolds and panels, impinges on the outside of the HPT case, and exits overboard through the core compartment vent.

LRUs

HPT ACC inlet duct,
HPT ACC air valve,
HPT ACC manifolds.


MANIFOLD AND PANELS
AIR DUCT
HPT ACC VALVE
FWD
V-BAND COUPLING
HPT ACC INLET AIR DUCT
V-BAND COUPLING
FLEXIBLE JOINT HOSE
HPT ACC AIR VALVE
ELECTRICAL CONNECTOR
HEAD TUBE
DRAIN TUBE
ROD TUBE
FWD
CTC70037.20061114

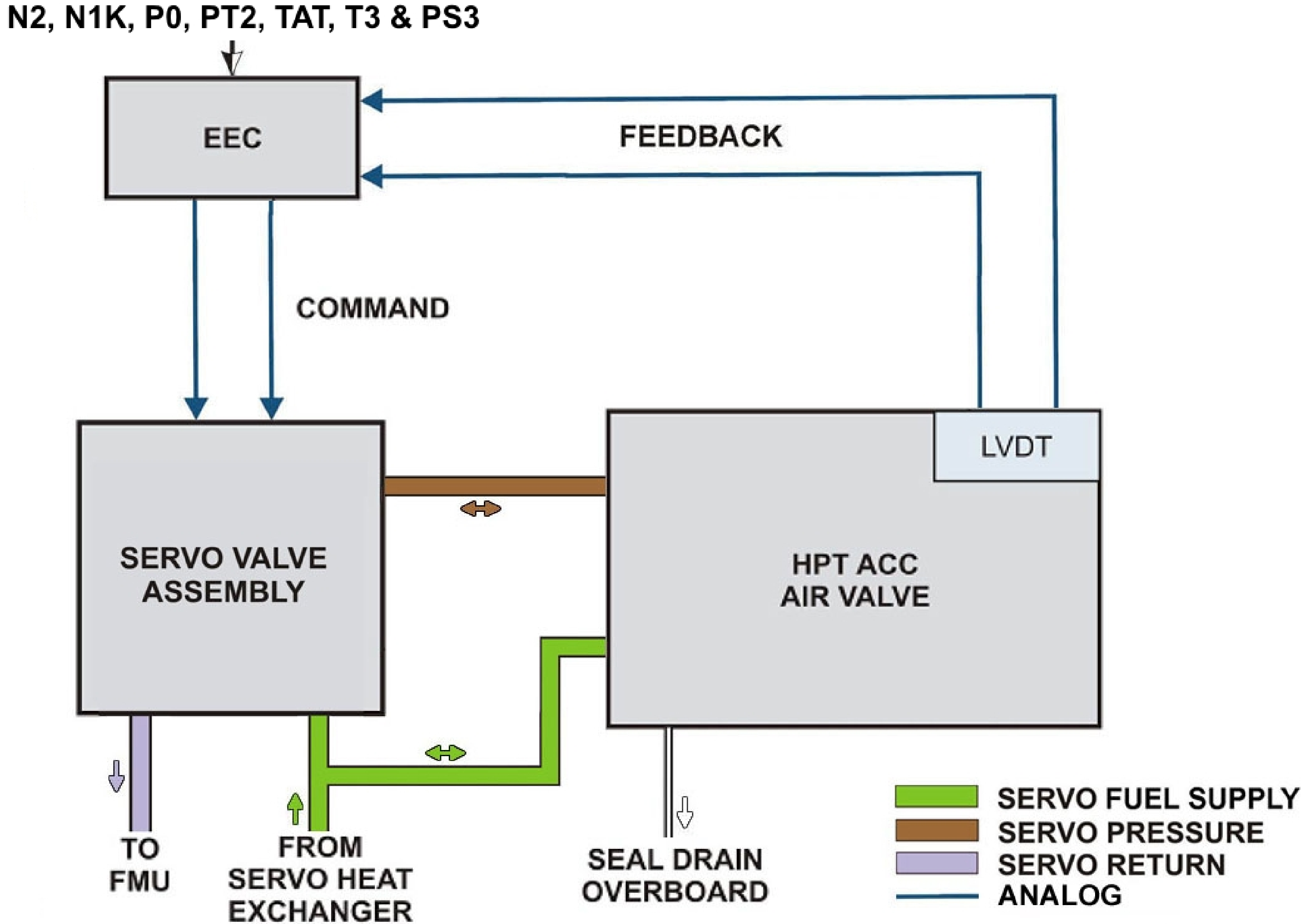
HPT ACTIVE CLEARANCE CONTROL - PURPOSE ... LRUS

ENGINE & ACCESSORY COOLING AIR (EA) (3)

HPT Active Clearance Control (continued)

Description and Operation (Continued)

The EEC determines the required HPT ACC valve position based on N2, N1K, P0, PT2, TAT, T3 and PS3 inputs.
The EEC sends an electrical signal to the Servo Valve Assembly (SVA), which controls the servo fuel to the HPT ACC valve.
The HPT ACC valve is modulated by servo fuel pressure, and controls the amount of fan air sent to the HPT ACC manifolds and panels.
If there is no EEC control, the valve failsafe position is closed.
A dual channel LVDT, inside the HPT ACC valve, provides position feedback to the EEC.


N2, N1K, P0, PT2, TAT, T3 & PS3
EEC
FEEDBACK
COMMAND
SERVO VALVE ASSEMBLY
LVDT
HPT ACC AIR VALVE
TO FMU
FROM SERVO HEAT EXCHANGER
SEAL DRAIN OVERBOARD
SERVO FUEL SUPPLY
SERVO PRESSURE
SERVO RETURN
ANALOG
CTC70032.20081020

HPT ACTIVE CLEARANCE CONTROL - DESCRIPTION AND OPERATION (CONTINUED)

ENGINE & ACCESSORY COOLING AIR (EA) (3)

LPT Active Clearance Control

Purpose

The LPT Active Clearance Control system (ACC) cools the Low Pressure Turbine (LPT) case to reduce turbine blade tip clearance and improve fuel efficiency.

Components

LPT ACC inlet duct:
- Located on the rear of the FHF at 2:00 o'clock.

LPT ACC air valve:
- Attached to the LPT ACC inlet duct aft of the FHF, at 2:00 o'clock.

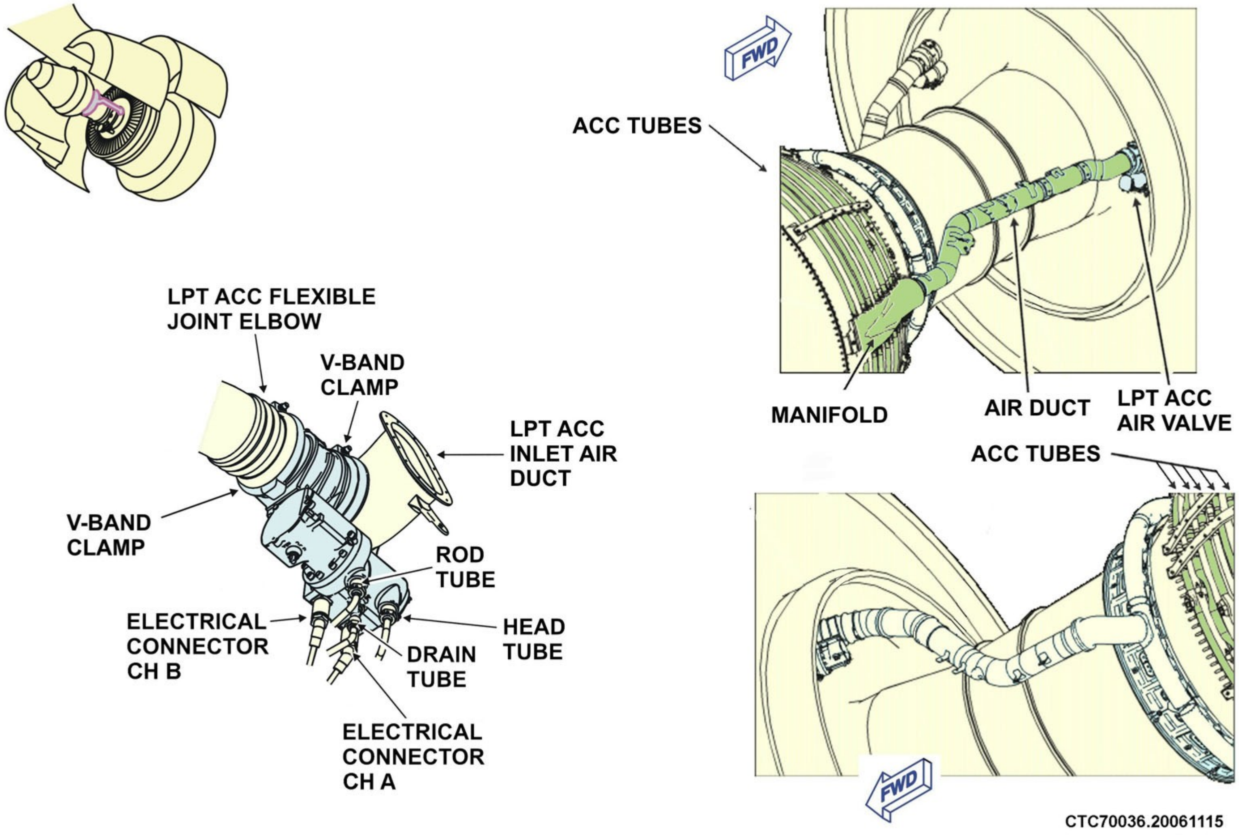
LPT ACC manifold and tubes:
- Manifold is located on the LPT case at 2:00 o'clock,
- Tubes are located circumferentially around the LPT case.

Description and Operation

The LPT ACC valve controls the amount of fan air sent through the air duct to the LPT ACC manifolds and tubes.
The cooling air exits from holes on the inner diameter of the manifolds and tubes, impinges on the outside of the LPT case, and exits overboard through the core compartment vent.

LRUs

LPT ACC air valve,
LPT ACC manifold and tubes.


LPT ACC FLEXIBLE JOINT ELBOW
V-BAND CLAMP
LPT ACC INLET AIR DUCT
V-BAND CLAMP
ROD TUBE
ELECTRICAL CONNECTOR CH B
HEAD TUBE
DRAIN TUBE
ELECTRICAL CONNECTOR CH A
FWD
ACC TUBES
MANIFOLD
AIR DUCT
LPT ACC AIR VALVE
ACC TUBES
FWD
CTC70036.20061115

LPT ACTIVE CLEARANCE CONTROL - PURPOSE ... LRUS

ENGINE & ACCESSORY COOLING AIR (EA) (3)

LPT Active Clearance Control (continued)

Description and Operation (Continued)

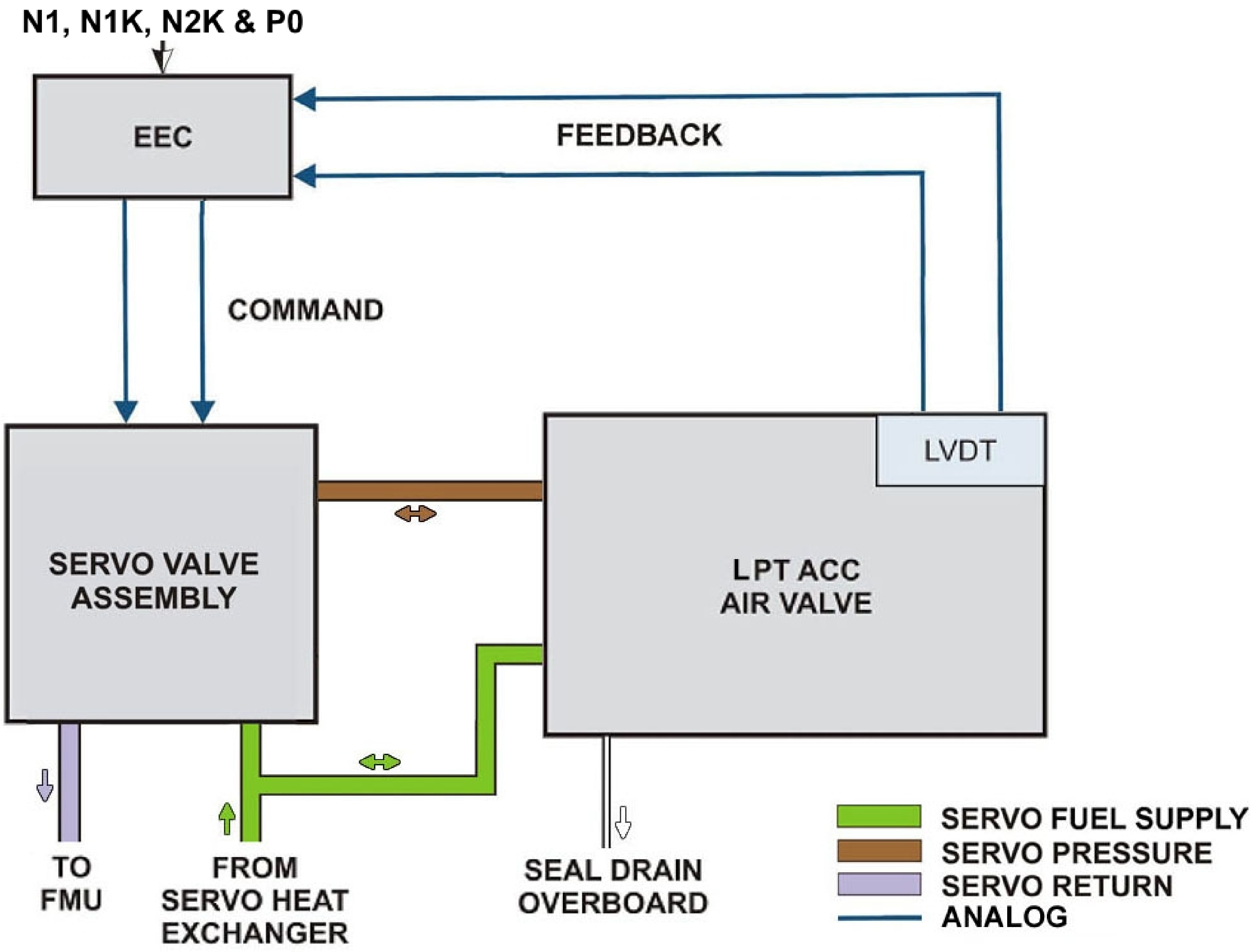
The EEC determines the required LPT ACC valve position based on N1, N1K, N2K, and P0 inputs.

The EEC sends and electrical signal to the Servo Valve Assembly (SVA), which controls the servo fuel to the LPT ACC valve.

The LPT ACC valve is modulated by servo fuel pressure, and controls the amount of cooling fan air ducted rearward to the LPT ACC manifold and tubes.

If there is no EEC control, the valve failsafe position is closed.

A dual channel LVDT, inside the LPT ACC valve, provides position feedback to the EEC.


N1, N1K, N2K & P0
EEC
FEEDBACK
COMMAND
LVDT
SERVO VALVE ASSEMBLY
LPT ACC AIR VALVE
TO FMU
FROM SERVO HEAT EXCHANGER
SEAL DRAIN OVERBOARD
🟩 SERVO FUEL SUPPLY
🟫 SERVO PRESSURE
▭ SERVO RETURN
— ANALOG

CTC70033.20081020

LPT ACTIVE CLEARANCE CONTROL - DESCRIPTION AND OPERATION (CONTINUED)

ENGINE & ACCESSORY COOLING AIR (EA) (3)

Core Compartment Cooling

Purpose

The Core Compartment Cooling (CCC) system cools and vents the core compartment.

Components

CCC ducts:
- Located circumferentially over the top of the HPC rear case from 9:00 o'clock to 3:00 o'clock.

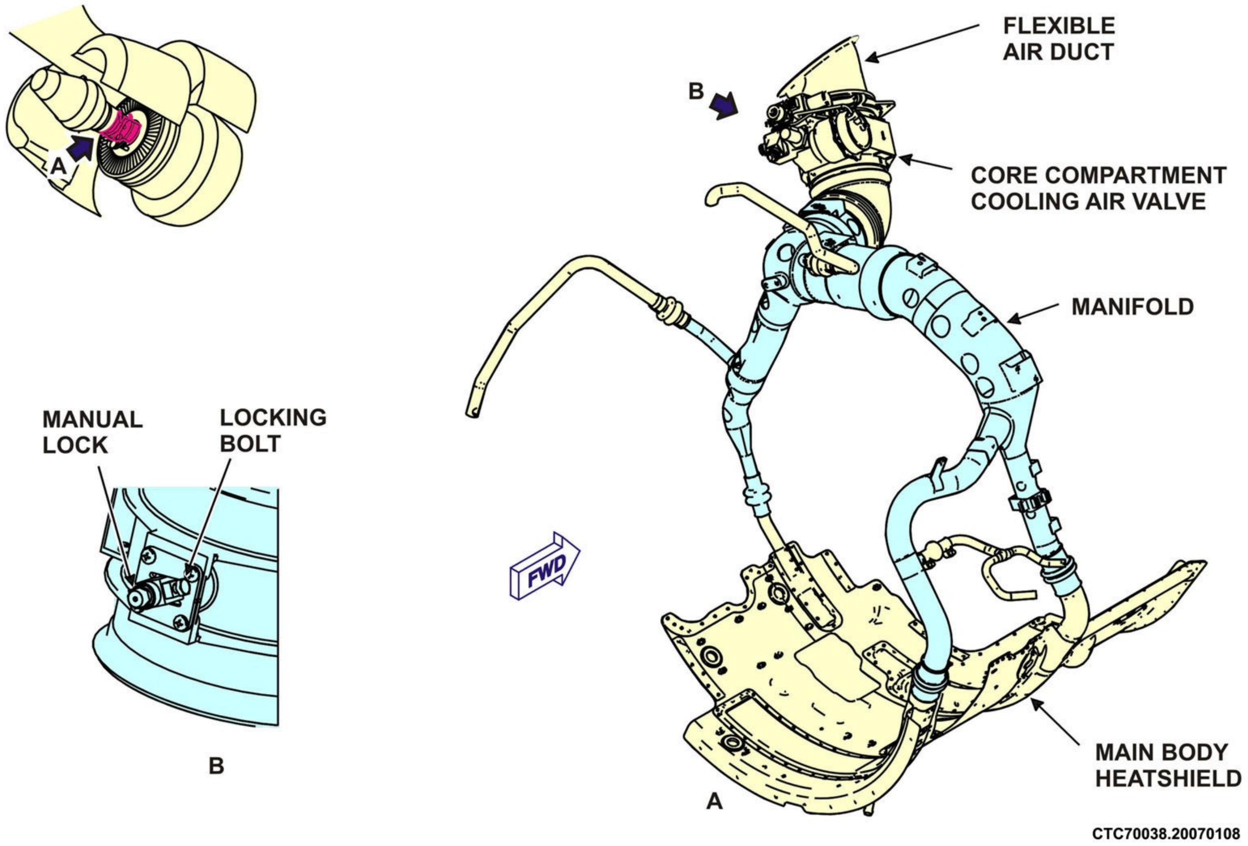
CCC air valve:
- Located aft of the FHF at 11:00 o'clock.

Description and Operation

The CCC valve controls the amount of cooling fan air ducted to the core compartment and components.
The air is then exhausted overboard through the gearbox and core engine vents.
The engine can be operated with the CCC system deactivated by manually locking the valve in the open position.

LRUs

CCC ducts,
CCC air valve.


A
FLEXIBLE
AIR DUCT
B
CORE COMPARTMENT
COOLING AIR VALVE
MANIFOLD
MANUAL
LOCK
LOCKING
BOLT
FWD
B
MAIN BODY
HEATSHIELD
A
CTC70038.20070108

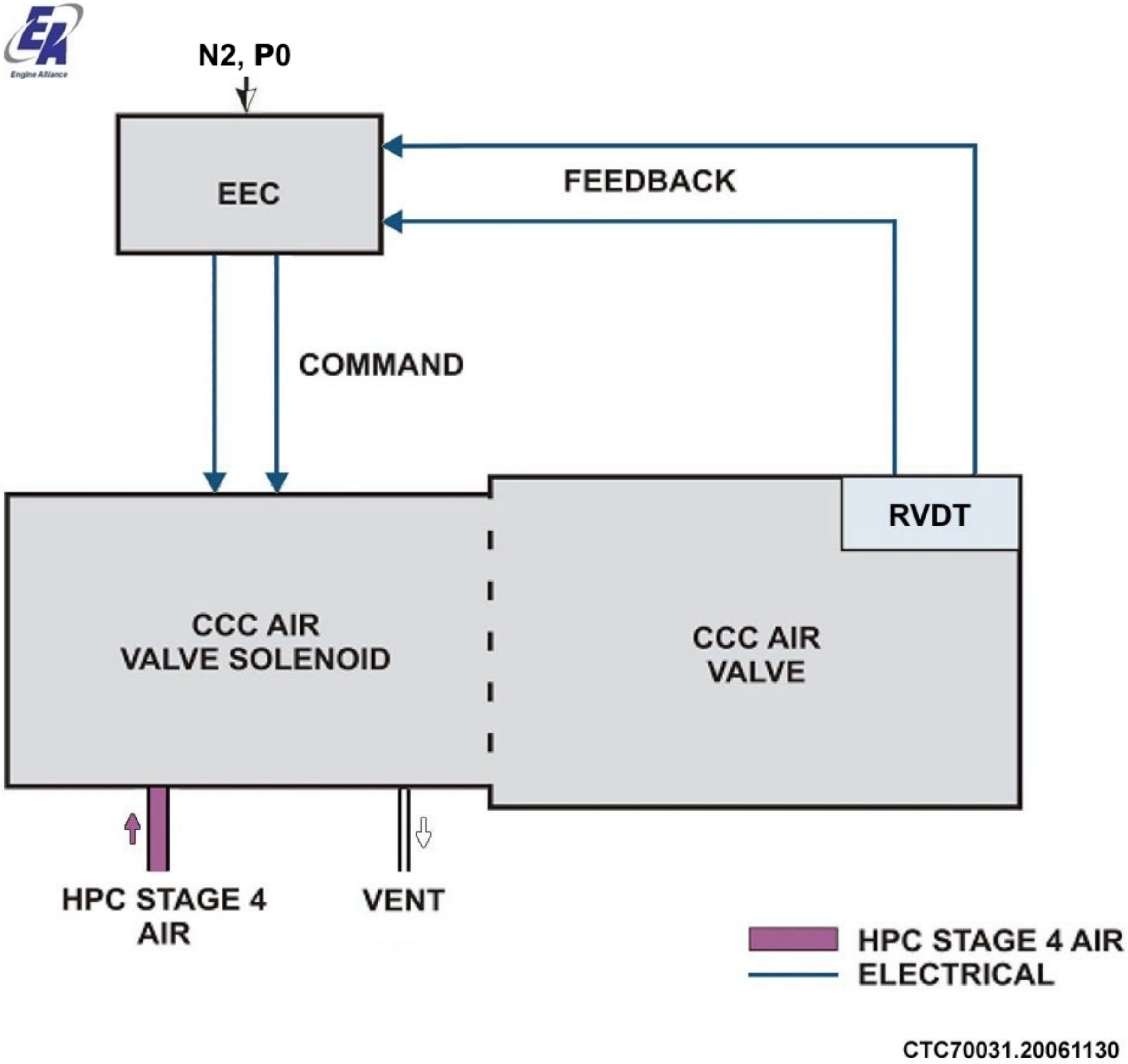
CORE COMPARTMENT COOLING - PURPOSE ... LRUS

ENGINE & ACCESSORY COOLING AIR (EA) (3)

Core Compartment Cooling (continued)

Description and Operation (Continued)

The EEC determines the required CCC valve position based on N2 and P0 inputs.
The EEC sends an electrical signal to the solenoid on the CCC valve, which sends 4th stage compressor air to move the CCC valve.
The CCC valve is closed by 4th stage compressor air and is spring loaded open.
A dual channel RVDT inside the CCC valve provides position feedback to the EEC.


N2, P0
EEC
FEEDBACK
COMMAND
RVDT
CCC AIR VALVE SOLENOID
CCC AIR VALVE
HPC STAGE 4 AIR
VENT
HPC STAGE 4 AIR
ELECTRICAL
CTC70031.20061130

CORE COMPARTMENT COOLING - DESCRIPTION AND OPERATION (CONTINUED)

ENGINE & ACCESSORY COOLING AIR (EA) (3)

Core Compartment Temperature Sensor

Purpose

The core compartment temperature sensor senses the temperature of the air under the cowl. It is used to sense hot air leaks.

Components

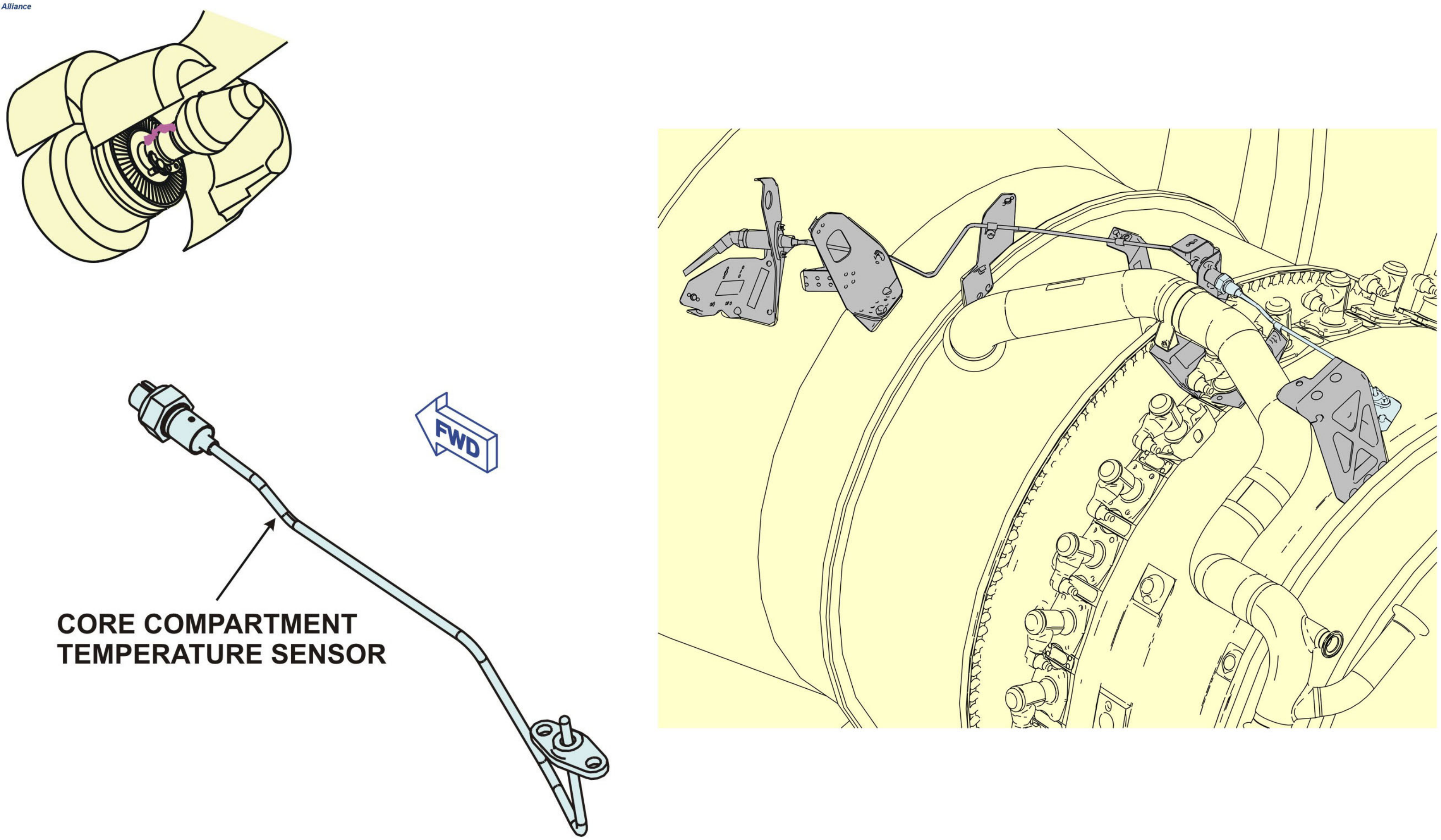
Core compartment temperature sensor:
- Mounted aft of the fuel nozzles at 11 o'clock.

Description and Operation

The core compartment temperature sensor sends the nacelle temperature to the EEC channel A and B.
The EEC converts the analog signal to a digital signal, and sends it to the aircraft's engine system display.

LRUs

Core compartment temperature sensor.


CORE COMPARTMENT TEMPERATURE SENSOR
FWD

CTC70035.20061120

CORE COMPARTMENT TEMPERATURE SENSOR - PURPOSE ... LRUS

OIL SYSTEM DESCRIPTION (EA) (3)

General Overview

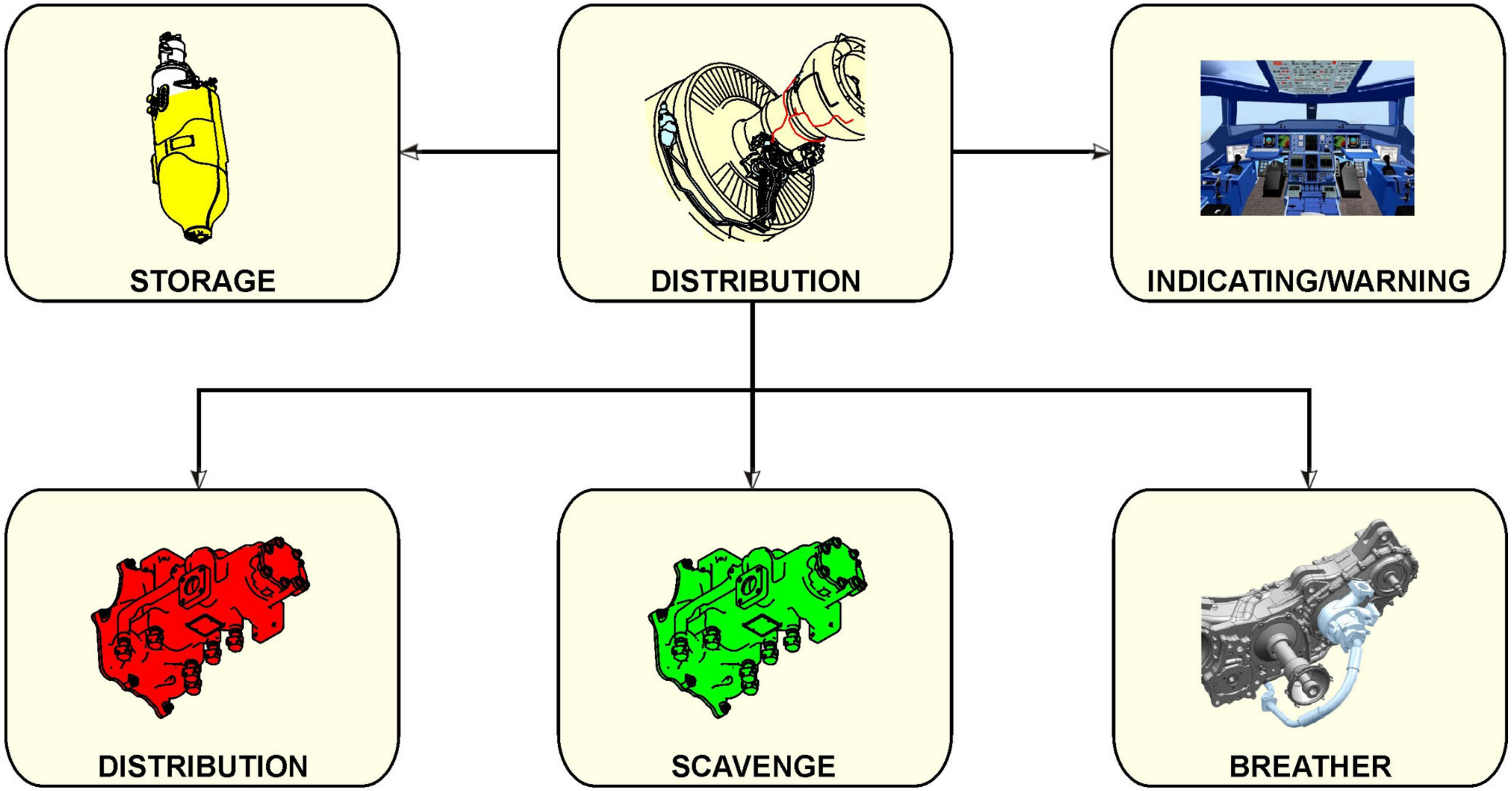
Purpose

The oil system stores the oil.
It supplies pressurized, filtered, cooled oil to lubricate, clean, and cool the engine bearings, gears, seals, and accessory drives.
It also heats the fuel.

Systems/Subsystems

Storage.
Distribution:
- Distribution,
- Scavenge,
- Breather.

Indicating/warning.


STORAGE
DISTRIBUTION
INDICATING/WARNING
DISTRIBUTION
SCAVENGE
BREATHER

CTC70072.20070108

OIL SYSTEM

GENERAL OVERVIEW - PURPOSE & SYSTEMS/SUBSYSTEMS

OIL SYSTEM DESCRIPTION (EA) (3)

Storage System

Purpose

The oil storage system stores the engine oil.

Components - Engine Right Side

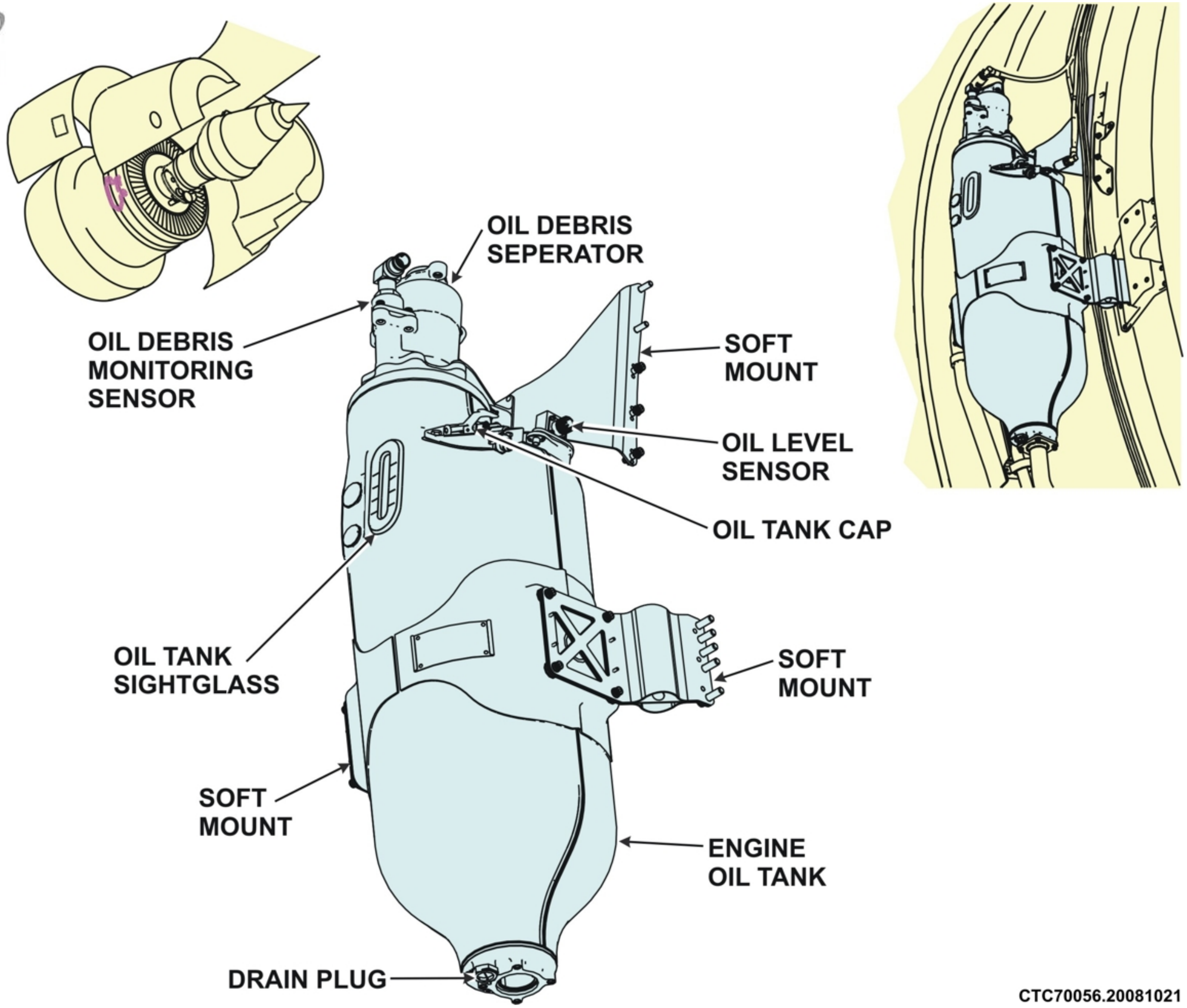
Oil tank:
- Attached to the aft fan case at 8:30 o'clock.
Oil tank cap:
- Attached to the top aft side of the oil tank.
Oil tank sightglass:
- Attached to the left side of the oil tank.
Oil Debris Monitoring (ODM) sensor:
- Attached to the top of the oil tank.
Oil debris separator:
- Attached to the top of the oil tank.
Oil level sensor:
- Attached to the top aft side of the oil tank next to the oil tank cap.
Oil tank drain plug:
Located at the bottom of the oil tank.

Description and Operation

The oil tank is attached to the aft fan case by soft mounts.
It is a "hot tank" system:
- The hot scavenge oil is sent to the oil tank.
Tank capacity:
- Approximately 7.0 U.S. gal (26.5 liters).
Oil quantity provision:
- Oil level sensor,
- Oil tank sightglass.
Oil Servicing:
- Manual fill:
. Hinged cap,
. An internal flapper valve in the manual fill opening prevents rapid loss of oil if the oil tank cap is not correctly installed.
- Oil tank drain plug.

LRUs

Oil tank,
Oil tank cap,
Oil tank sightglass,
Oil Debris Monitoring (ODM) sensor,
Oil level sensor,
Oil tank drain plug.


OIL DEBRIS SEPERATOR
OIL DEBRIS MONITORING SENSOR
SOFT MOUNT
OIL LEVEL SENSOR
OIL TANK CAP
OIL TANK SIGHTGLASS
SOFT MOUNT
SOFT MOUNT
ENGINE OIL TANK
DRAIN PLUG
CTC70056.20081021

STORAGE SYSTEM - PURPOSE ... LRUS

OIL SYSTEM DESCRIPTION (EA) (3)

Distribution System - Distribution Subsystem

Purpose

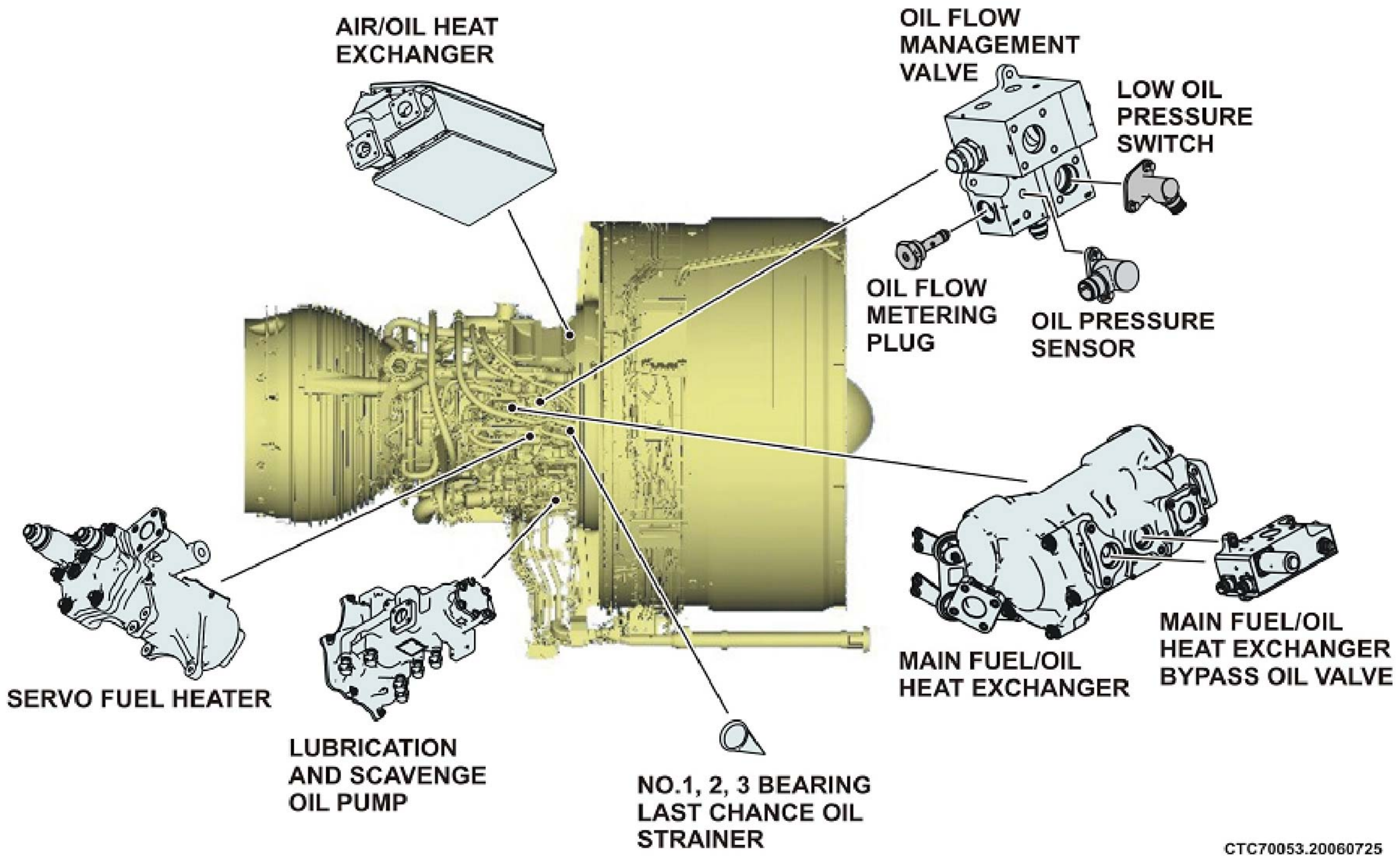
The oil distribution subsystem supplies temperature-regulated, non-pressure-regulated, filtered oil to lubricate, clean, and cool the engine bearings, gears, seals, and accessory drives.
It also heats the fuel.

Components - Engine Right Side

Lubrication and Scavenge Oil Pump (LSOP):
- Attached to the front side of the MGB at 6:00 o'clock.
Oil Flow Management Valve (OFMV):
- Attached to the front of the main fuel/oil heat exchanger at 2:30 o'clock.
Main fuel/oil heat exchanger:
- Attached to the HPC rear case at 2:30 o'clock.
Main fuel/oil heat exchanger bypass valve:
- Attached to the main fuel/oil heat exchanger.
Air/oil heat exchanger:
- Attached to the rear of the fan hub frame at 1:00 o'clock.
Servo fuel heater:
- Attached to the end of the MGB at 3:00 o'clock.
Oil pressure sensor:
- Attached to the oil flow management valve.
Low oil pressure switch:
- Attached to the OFMV.
No. 1, 2, and 3 bearing last chance oil strainer:
- Located on the rear of the fan hub frame at 4:00 o'clock.

LRUs

Lubrication and Scavenge Oil Pump (LSOP),
Oil Flow Management Valve (OFMV),
Main fuel/oil heat exchanger,
Main fuel/oil heat exchanger bypass valve,
Air /oil heat exchanger,
Servo fuel heater,
Oil pressure sensor,
Low oil pressure switch,
No. 1, 2 and 3 bearing last chance oil strainer.


AIR/OIL HEAT EXCHANGER
OIL FLOW MANAGEMENT VALVE
LOW OIL PRESSURE SWITCH
OIL FLOW METERING PLUG
OIL PRESSURE SENSOR
SERVO FUEL HEATER
MAIN FUEL/OIL HEAT EXCHANGER
MAIN FUEL/OIL HEAT EXCHANGER BYPASS OIL VALVE
LUBRICATION AND SCAVENGE OIL PUMP
NO.1, 2, 3 BEARING LAST CHANCE OIL STRAINER
CTC70053.20060725

DISTRIBUTION COMPONENTS - ENGINE RIGHT SIDE

DISTRIBUTION SYSTEM - DISTRIBUTION SUBSYSTEM - PURPOSE ... LRUS

OIL SYSTEM DESCRIPTION (EA) (3)

Distribution System - Distribution Subsystem (continued)

Components - Engine Left Side

Main oil filter:
- Located in the main oil filter housing which is attached to the rear of the main gearbox at 8:00 o'clock.

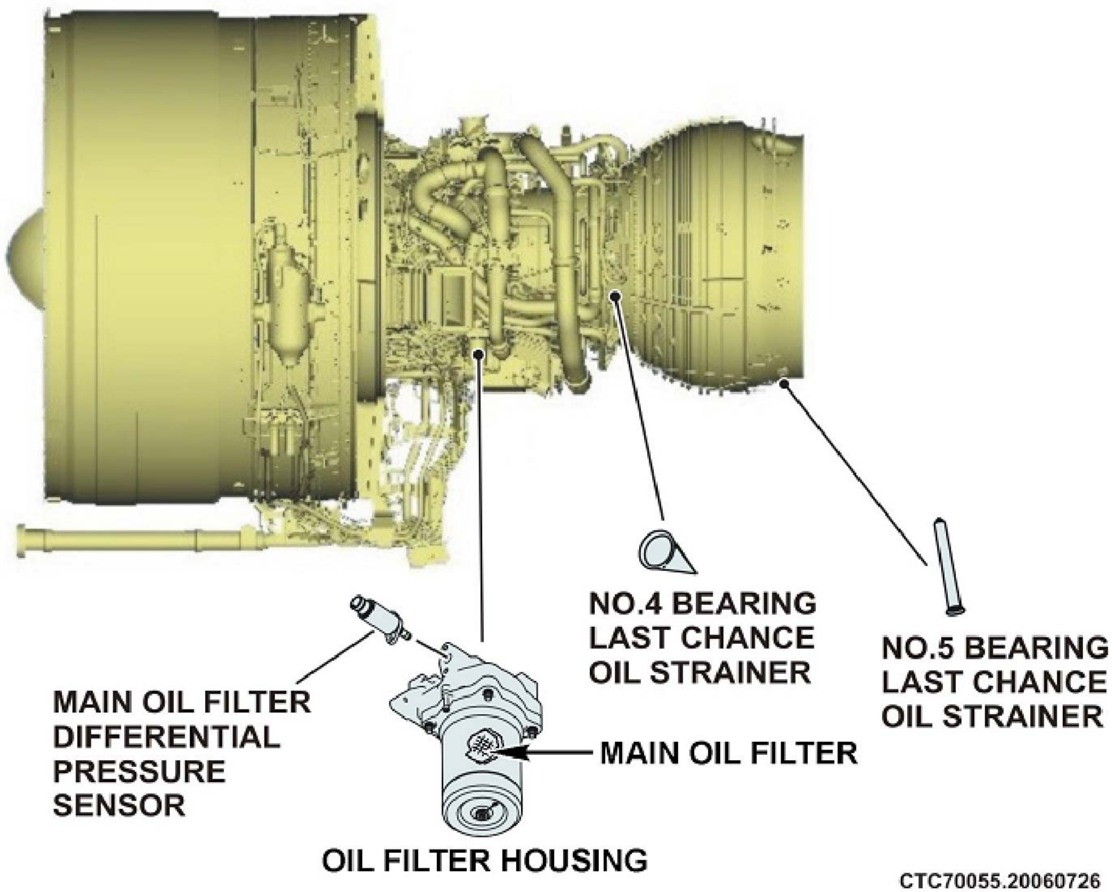
Main oil filter differential pressure sensor:
- Attached to the main oil filter housing.

No. 4 bearing last chance strainer:
- Located in the turbine center frame at 8:00 o'clock.

No. 5 bearing last chance strainer:
- Located in the turbine exhaust case at 6:30 o'clock.

LRUs

Oil filter housing,
Main oil filter,
Main oil filter differential pressure sensor,
No. 4 bearing last chance strainer,
No. 5 bearing last chance strainer.


NO.4 BEARING LAST CHANCE OIL STRAINER
NO.5 BEARING LAST CHANCE OIL STRAINER
MAIN OIL FILTER DIFFERENTIAL PRESSURE SENSOR
MAIN OIL FILTER
OIL FILTER HOUSING

CTC70055.20060726

DISTRIBUTION COMPONENTS - ENGINE LEFT SIDE

DISTRIBUTION SYSTEM - DISTRIBUTION SUBSYSTEM - COMPONENTS - ENGINE LEFT SIDE & LRUS

LB408521 - L5CT0T0 - LM7E9B000000001

OIL SYSTEM DESCRIPTION (EA) (3)

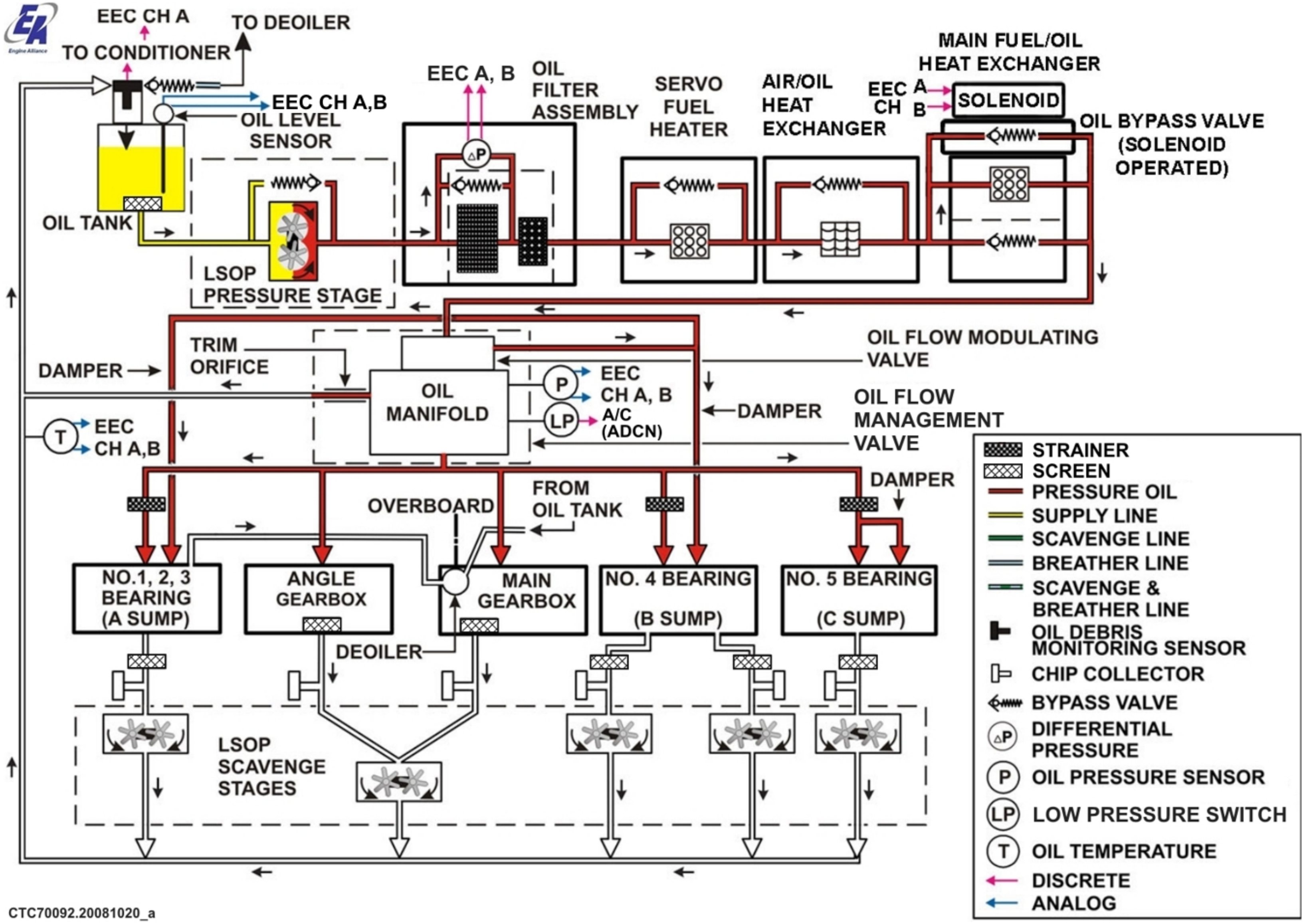
Distribution System - Distribution Subsystem (continued)

Description and Operation

Oil flows through a screen in the bottom of the oil tank to the pressure stage in the lubrication and scavenge oil pump (LSOP).
The lubrication stage discharge pressure is limited to 325-400 psid by the high pressure relief valve:
- Pressure in excess of 325 psid will cause the valve to start to open, allowing some of the oil to return to the inlet of the LSOP lubrication stage,
- If the pressure reaches 400 psid, the valve will be fully open.

The lubrication stage sends the oil to the dual element main oil filter. If the main oil filter primary element is partially clogged, a filter bypass valve opens to let the oil bypass the primary element.
An oil filter differential pressure sensor measures the pressure differential across the main oil filter to detect a clogged element and sends a signal to the EEC.
From the main oil filter, oil flows to the servo fuel heater, the engine air/oil heat exchanger, and the main fuel/oil heat exchanger providing fuel heating and oil cooling. The main fuel/oil heat exchanger has a bypass valve, this valve is commanded by the EEC with a solenoid, to control whether the oil flows through or around the core of the heat exchanger to prevent in certain condition excessive fuel heating.
Oil then flows from the fuel/oil heat exchanger to the Oil Flow Management Valve (OFMV):
- An oil pressure sensor and a low oil pressure switch are mounted on the OFMV,
- Oil pressure sensor output is sent to the EEC,
- The low oil pressure switch sends its output to the aircraft Avionics Data Communications Network (ADCN)
- The OFMV includes an oil distribution manifold and an oil flow modulating valve,
- The distribution manifold supplies oil to the:
  . No. 1, 2, and 3 bearing compartment,
  . No. 4 bearing compartment,
  . No. 5 bearing compartment,
  . Angle gearbox,
  . Main gearbox,
  . Starter (through an oil transfer tube located in the main gearbox),
  . Trim orifice (located in the manifold).
- Oil flows through the trim orifice back to the oil tank. The trim orifice fine tunes the oil flow and pressure.
- The oil flow modulating valve provides oil pressure to dampen the No. 3 and 4 bearings.
- The OFMV has a drain/vent line that drains any internal leakage to the main gearbox, and it vents the main oil sensor to system breather pressure.

Last chance oil strainers protect the bearings and gears from large contaminates:
- No. 1, No. 2, and No. 3 bearing oil strainer,
- No. 4 bearing oil strainer,
- No. 5 bearing oil strainer.


EEC CH A
TO DEOILER
TO CONDITIONER
EEC CH A,B
OIL LEVEL SENSOR
OIL TANK
LSOP PRESSURE STAGE
EEC A, B
OIL FILTER ASSEMBLY
SERVO FUEL HEATER
AIR/OIL HEAT EXCHANGER
MAIN FUEL/OIL HEAT EXCHANGER
EEC CH A
B
SOLENOID
OIL BYPASS VALVE (SOLENOID OPERATED)
DAMPER
TRIM ORIFICE
OIL MANIFOLD
EEC CH A, B
A/C (ADCN)
OIL FLOW MODULATING VALVE
DAMPER
OIL FLOW MANAGEMENT VALVE
EEC CH A,B
DAMPER
OVERBOARD
FROM OIL TANK
NO.1, 2, 3 BEARING (A SUMP)
ANGLE GEARBOX
MAIN GEARBOX
NO. 4 BEARING (B SUMP)
NO. 5 BEARING (C SUMP)
DEOILER
LSOP SCAVENGE STAGES
STRAINER
SCREEN
PRESSURE OIL
SUPPLY LINE
SCAVENGE LINE
BREATHER LINE
SCAVENGE & BREATHER LINE
OIL DEBRIS MONITORING SENSOR
CHIP COLLECTOR
BYPASS VALVE
ΔP DIFFERENTIAL PRESSURE
P OIL PRESSURE SENSOR
LP LOW PRESSURE SWITCH
T OIL TEMPERATURE
DISCRETE
ANALOG
CTC70092.20081020_a

DISTRIBUTION SYSTEM - DISTRIBUTION SUBSYSTEM - DESCRIPTION AND OPERATION

OIL SYSTEM DESCRIPTION (EA) (3)

Distribution System - Scavenge Subsystem

Purpose

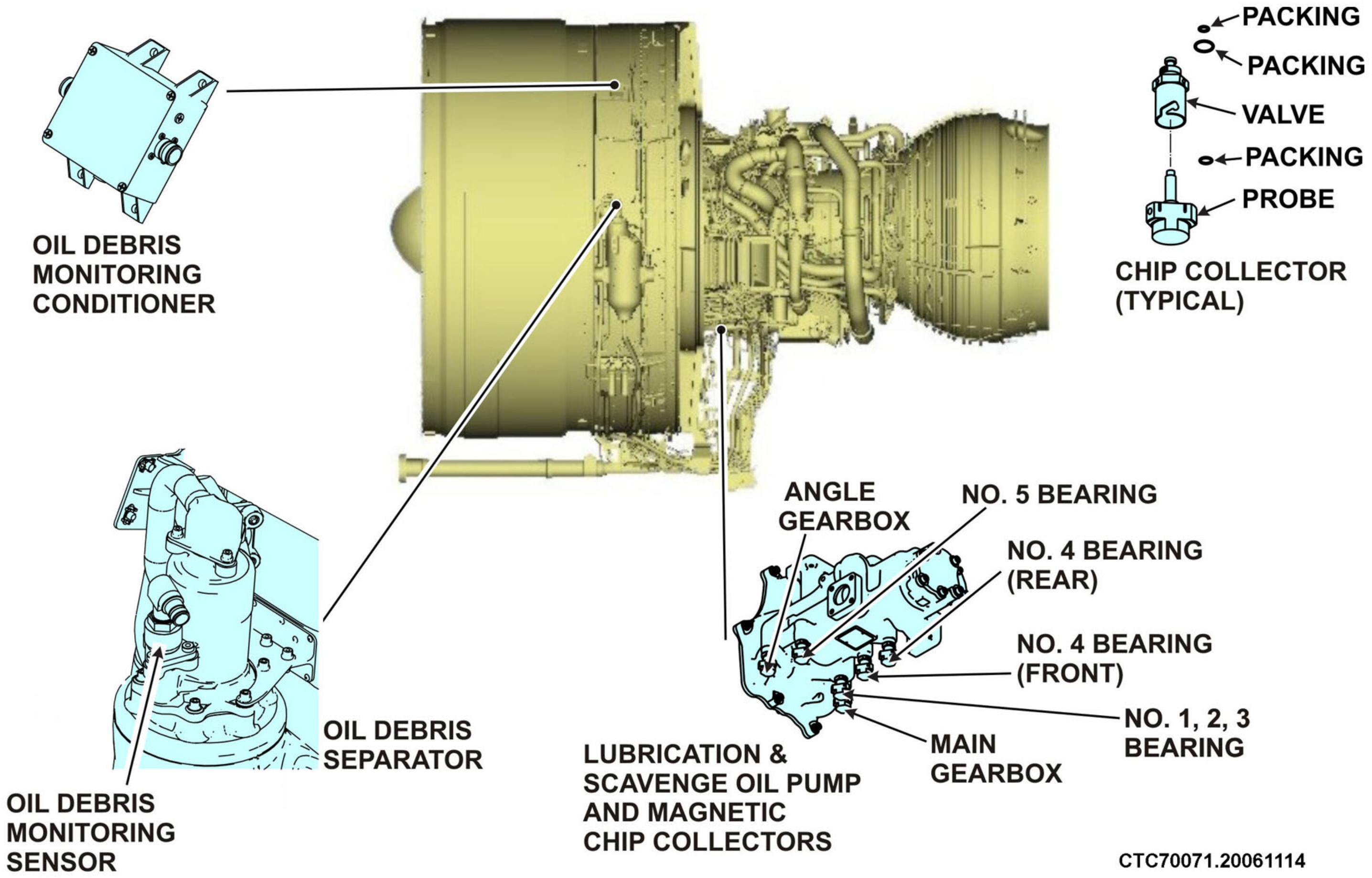
The scavenge subsystem returns the hot oil to the oil tank.

Components

Lubrication and Scavenge Oil Pump (LSOP):
- Attached to the front of the MGB at 6:00 o'clock.
Magnetic chip collectors:
- No. 1, 2, 3 bearing chip collector:
. Inserted in the LSOP at 6:00 o'clock.
- No. 4 bearing front and rear chip collectors:
. Inserted in the LSOP at 6:00 o'clock.
- No. 5 bearing chip collector:
. Inserted in the LSOP at 6:00 o'clock.
- AGB chip collector:
. Inserted in the LSOP at 6:00 o'clock.
- MGB chip collector:
. Inserted in the LSOP at 6:00 o'clock.
- Oil Debris Monitoring (ODM) System.
- Debris separator:
. Mounted on the top of the oil tank at 9:30.
- Sensor:
. Part of the air oil separator at the top of the oil tank at 9:30 o'clock.
- Conditioner:
. Attached to the rear fan case at 11:00 o'clock.

LRUs

Lubrication and Scavenge Oil Pump (LSOP),
Oil Debris Monitoring Sensor (ODM),
Oil Debris Monitoring Conditioner,
MGB chip collector,
No. 4 Bearing front and rear chip collectors,
AGB chip collector,
No. 1, 2, 3 bearing chip collector,
No. 5 bearing chip collector.


PACKING
PACKING
VALVE
PACKING
PROBE
CHIP COLLECTOR (TYPICAL)
OIL DEBRIS MONITORING CONDITIONER
ANGLE GEARBOX
NO. 5 BEARING
NO. 4 BEARING (REAR)
NO. 4 BEARING (FRONT)
NO. 1, 2, 3 BEARING
MAIN GEARBOX
OIL DEBRIS SEPARATOR
LUBRICATION & SCAVENGE OIL PUMP AND MAGNETIC CHIP COLLECTORS
OIL DEBRIS MONITORING SENSOR
CTC70071.20061114

OIL SCAVENGE - COMPONENTS

DISTRIBUTION SYSTEM - SCAVENGE SUBSYSTEM - PURPOSE ... LRUS

OIL SYSTEM DESCRIPTION (EA) (3)

Distribution System - Scavenge Subsystem (continued)

Description and Operation

The No. 1, 2, 3, (A sump), No. 4 (B sump) and No. 5 (C sump) bearing compartments, the MGB, and AGB scavenge oil is returned to the oil tank by five scavenge pump stages in the LSOP.

The five scavenge pump stages send the scavenge oil to the air-oil separator in the oil tank where the air is separated from the oil and sent to the overboard vent.

The No. 4 bearing compartment (B-sump) is scavenged by two lubrication and scavenge oil pump stages.

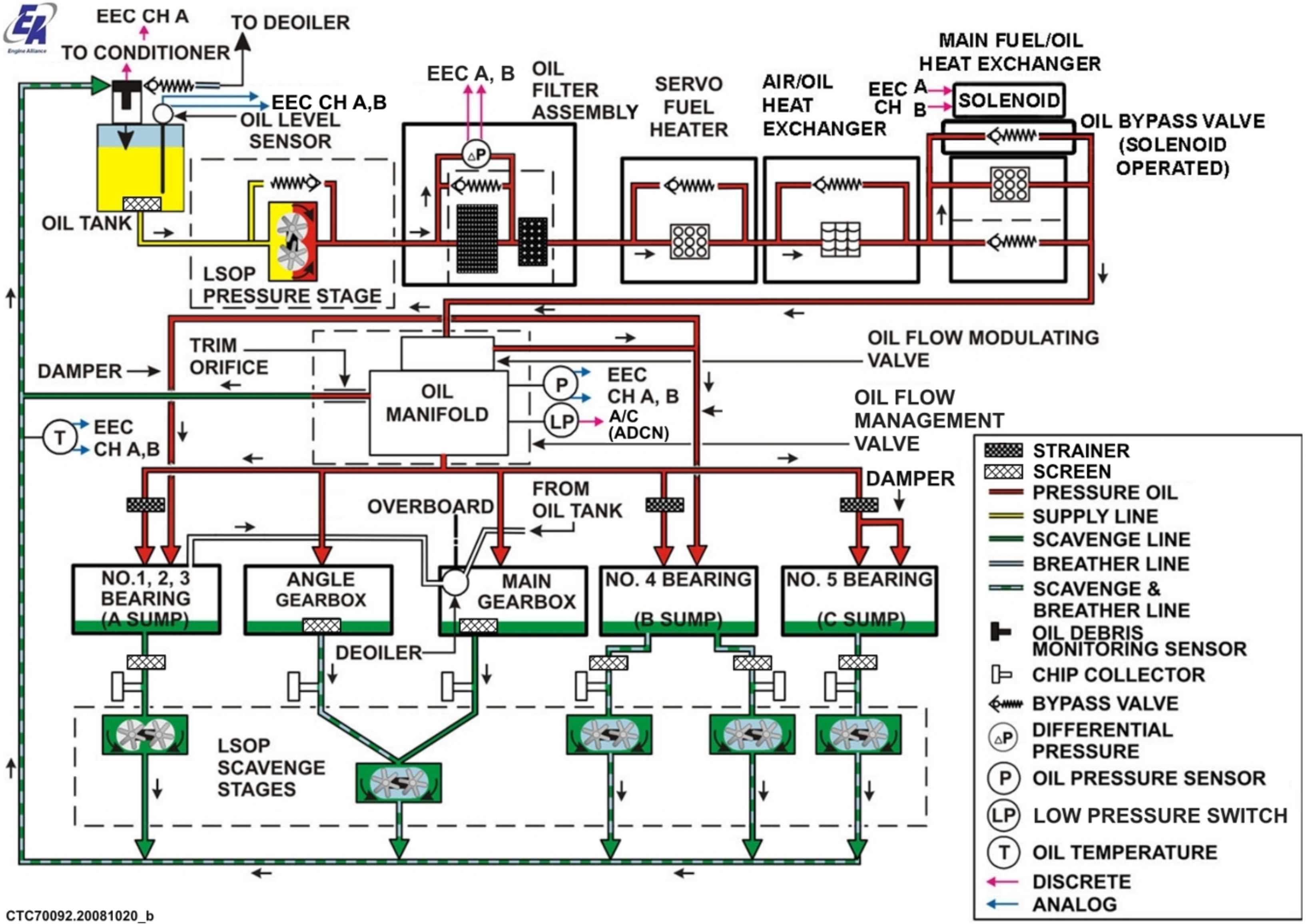
The AGB and the MGB share a common lubrication and scavenge oil pump scavenge stage, but each has its own scavenge line and inlet connector to the pump.

The main oil temperature sensor measures oil temperature before the scavenged oil returns to the oil tank.

There are six magnetic chip collectors which catch ferrous particles that might be in the scavenge oil. The collectors are located at the inlet of each of the lubrication and scavenge oil pump scavenge stages.

The oil debris monitoring system is made up of three items:

- The debris separator, separates debris from the oil/air mixture and sends any debris to the sensor,
- Oil Debris Monitoring Sensor (ODM), is an electronic master chip detector:
  . Any Ferrous metal particles that it collects cause an electronic signal to be generated and sent to the oil debris conditioner,
- The oil debris conditioner sends its signal to the EEC channel A.


EEC CH A
TO DEOILER
TO CONDITIONER
EEC CH A,B
OIL LEVEL SENSOR
OIL TANK
LSOP PRESSURE STAGE
EEC A, B
OIL FILTER ASSEMBLY
ΔP
SERVO FUEL HEATER
AIR/OIL HEAT EXCHANGER
EEC CH A
B
MAIN FUEL/OIL HEAT EXCHANGER
SOLENOID
OIL BYPASS VALVE (SOLENOID OPERATED)
TRIM ORIFICE
DAMPER
OIL MANIFOLD
P
LP
EEC CH A, B
A/C (ADCN)
OIL FLOW MODULATING VALVE
OIL FLOW MANAGEMENT VALVE
T
EEC CH A,B
OVERBOARD
FROM OIL TANK
DAMPER
NO.1, 2, 3 BEARING (A SUMP)
ANGLE GEARBOX
MAIN GEARBOX
NO. 4 BEARING (B SUMP)
NO. 5 BEARING (C SUMP)
DEOILER
LSOP SCAVENGE STAGES
STRAINER
SCREEN
PRESSURE OIL
SUPPLY LINE
SCAVENGE LINE
BREATHER LINE
SCAVENGE & BREATHER LINE
OIL DEBRIS MONITORING SENSOR
CHIP COLLECTOR
BYPASS VALVE
DIFFERENTIAL PRESSURE
OIL PRESSURE SENSOR
LOW PRESSURE SWITCH
OIL TEMPERATURE
DISCRETE
ANALOG
CTC70092.20081020_b

DISTRIBUTION SYSTEM - SCAVENGE SUBSYSTEM - DESCRIPTION AND OPERATION

LB408521 - L5CT0T0 - LM7E9B000000001

OIL SYSTEM DESCRIPTION (EA) (3)

Distribution System - Breather Subsystem

Purpose

The breather subsystem vents breather air from the bearing compartments and the angle and main gearboxes.
It separates air from the breather air/oil mixture, and vents the air overboard.

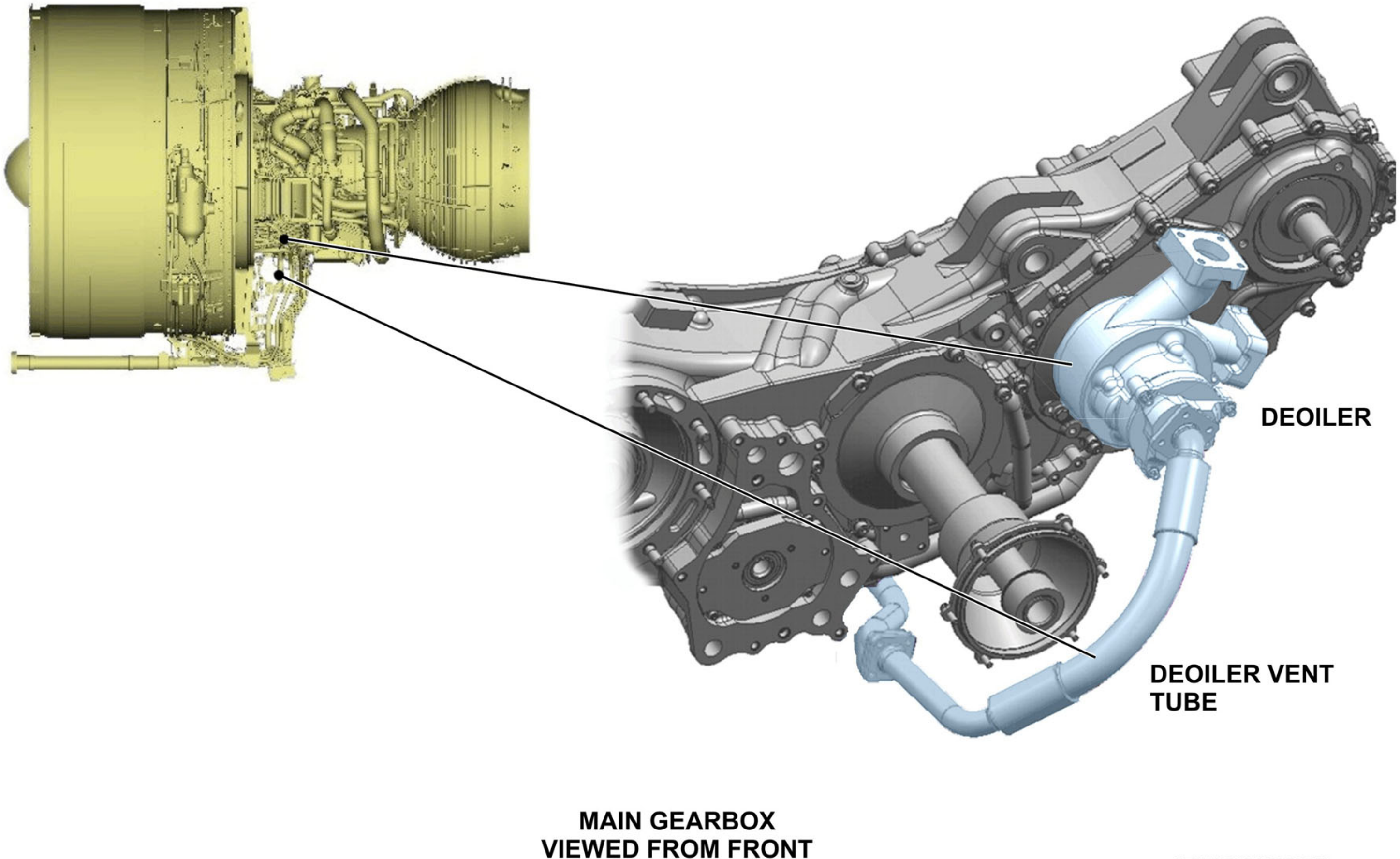
Components

Deoiler:
- Attached to the left front side of the MGB at 7o'clock.

Deoiler vent duct:
- Attached to the deoiler.

LRUs

Deoiler vent duct.


DEOILER
DEOILER VENT TUBE
MAIN GEARBOX VIEWED FROM FRONT
CTC70088.20060728

OIL BREATHER - COMPONENTS

DISTRIBUTION SYSTEM - BREATHER SUBSYSTEM - PURPOSE ... LRUS

OIL SYSTEM DESCRIPTION (EA) (3)

Distribution System - Breather Subsystem (continued)

Description and Operation

The No. 1, No. 2, and No. 3 bearing compartment breather air flows through a dedicated vent tube to the deoiler.

The No. 4 and 5 bearing compartments, and the AGB breather air is returned to the oil tank air/oil separator with the scavenge oil.

The air/oil separator, separates the breather air from the scavenge oil.

The oil drains into the tank, and the air is sent to the main gearbox through the oil tank pressurization valve.

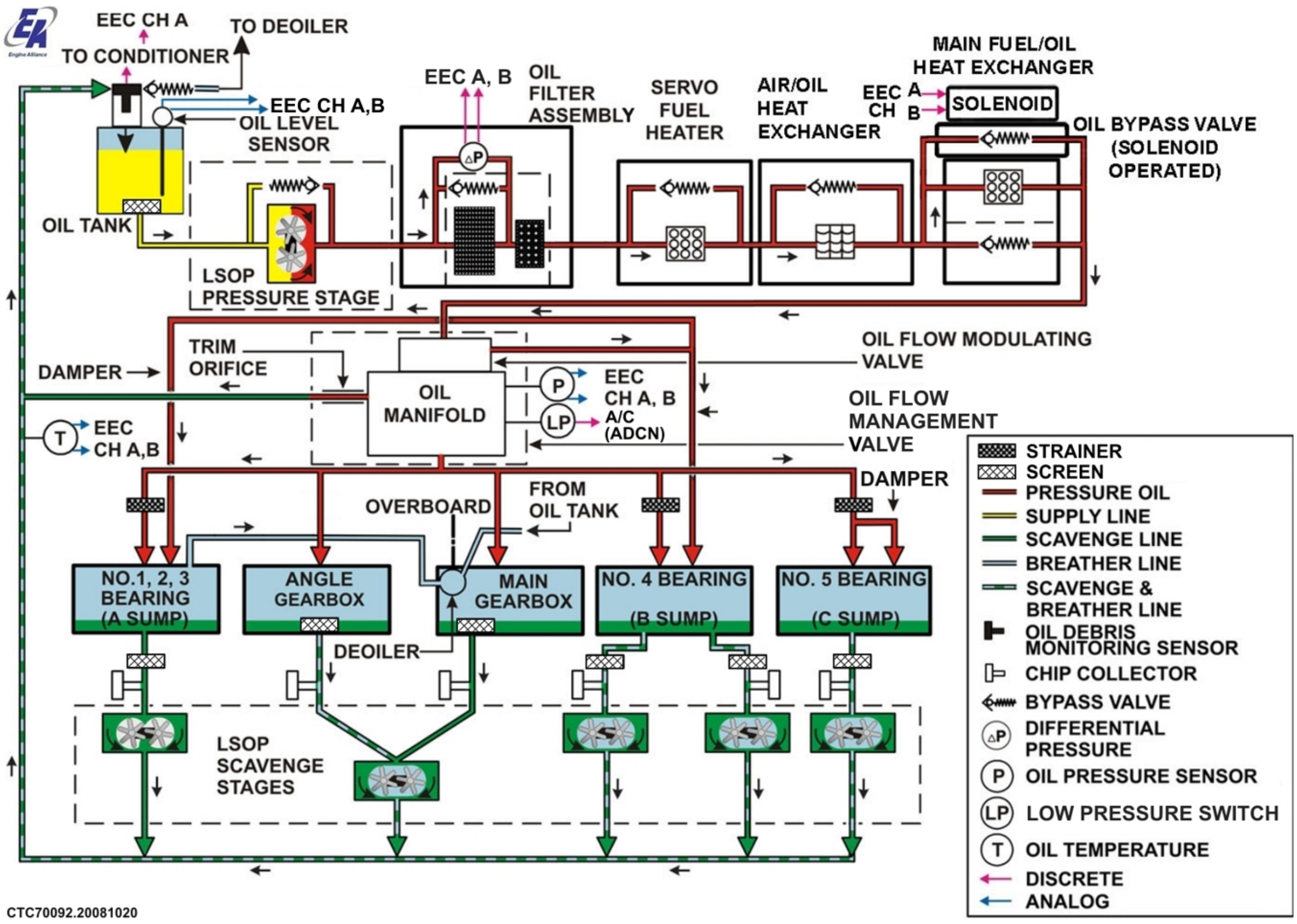
In the main gearbox the breather air flows to the deoiler.

The centrifugal force created by the rotating deoiler separates the oil from the air.

The air is vented overboard through the deoiler vent duct.

The oil drains to the main gearbox through an internal passage, mixes with the main gearbox scavenge oil, and is returned to the oil tank.

When the tank breather pressure reaches10 psi, the oil tank mounted pressurization valve opens and sends the excess pressure to the main gearbox.


EEC CH A
TO DEOILER
TO CONDITIONER
EEC CH A,B
OIL LEVEL SENSOR
OIL TANK
LSOP PRESSURE STAGE
EEC A, B
OIL FILTER ASSEMBLY
SERVO FUEL HEATER
AIR/OIL HEAT EXCHANGER
EEC CH A
EEC CH B
MAIN FUEL/OIL HEAT EXCHANGER
SOLENOID
OIL BYPASS VALVE (SOLENOID OPERATED)
ΔP
DAMPER
TRIM ORIFICE
OIL MANIFOLD
P
LP
EEC CH A, B
A/C (ADCN)
OIL FLOW MODULATING VALVE
OIL FLOW MANAGEMENT VALVE
T
EEC CH A,B
OVERBOARD
FROM OIL TANK
DAMPER
NO.1, 2, 3 BEARING (A SUMP)
ANGLE GEARBOX
MAIN GEARBOX
NO. 4 BEARING (B SUMP)
NO. 5 BEARING (C SUMP)
DEOILER
LSOP SCAVENGE STAGES
STRAINER
SCREEN
PRESSURE OIL
SUPPLY LINE
SCAVENGE LINE
BREATHER LINE
SCAVENGE & BREATHER LINE
OIL DEBRIS MONITORING SENSOR
CHIP COLLECTOR
BYPASS VALVE
ΔP DIFFERENTIAL PRESSURE
P OIL PRESSURE SENSOR
LP LOW PRESSURE SWITCH
T OIL TEMPERATURE
DISCRETE
ANALOG
CTC70092.20081020

DISTRIBUTION SYSTEM - BREATHER SUBSYSTEM - DESCRIPTION AND OPERATION

OIL SYSTEM DESCRIPTION (EA) (3)

Indicating/Warning

Purpose

Monitor the oil system conditions.
Provides inputs to the EEC.
Make the flight/maintenance personnel aware of potential oil system problems.

Components - Engine Right Side

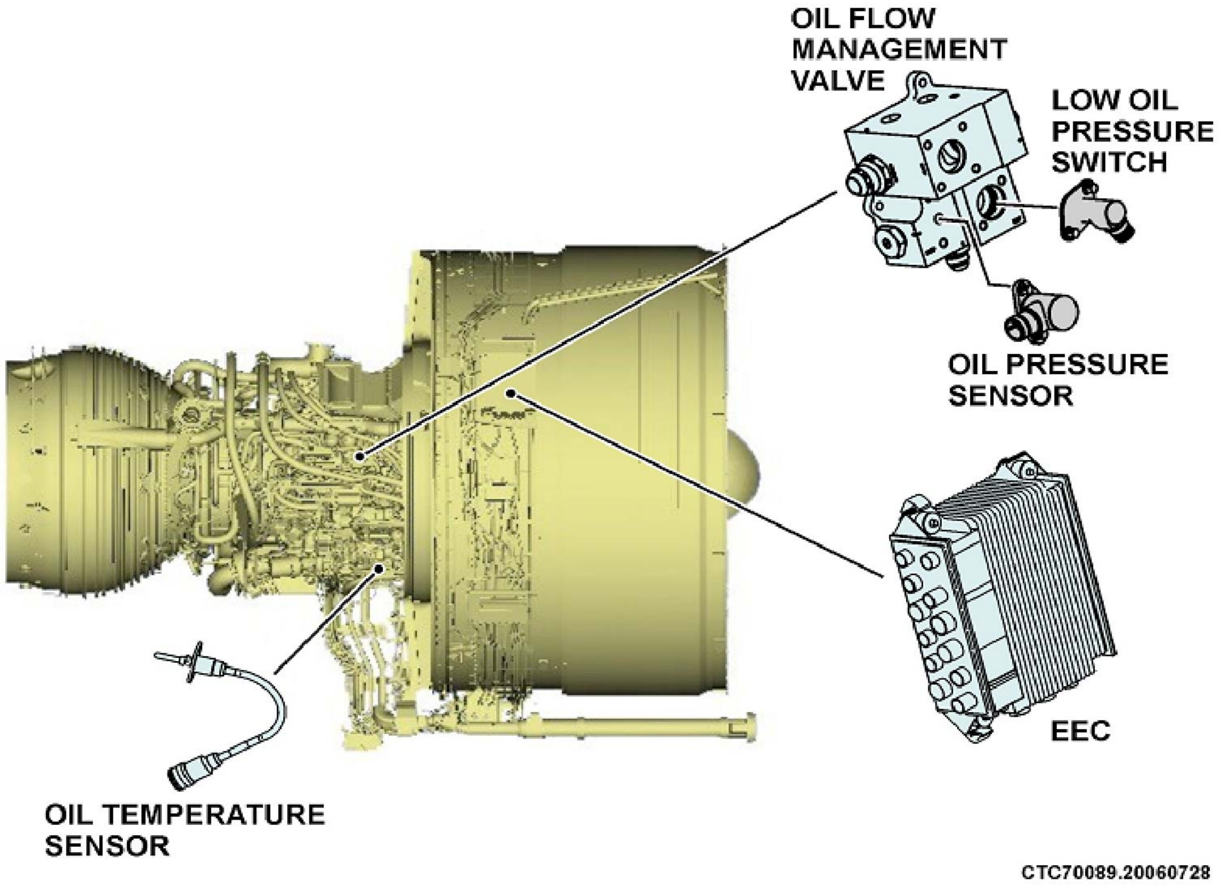
Oil temperature sensor:
- Attached to the oil scavenge return tube that is connected to the oil scavenge pump discharge port at 5:30 o'clock.

Oil pressure sensor:
- Attached to the oil flow management valve (OFMV) at the pressure fitting at 2:30.

Low oil pressure switch:
- Attached to the OFMV at 2:30.

LRUs

Oil temperature sensor,
Oil pressure sensor,
Low oil pressure switch.


OIL FLOW MANAGEMENT VALVE
LOW OIL PRESSURE SWITCH
OIL PRESSURE SENSOR
EEC
OIL TEMPERATURE SENSOR
CTC70089.20060728

INDICATION AND WARNING - ENGINE RIGHT SIDE

INDICATING/WARNING - PURPOSE ... LRUS

OIL SYSTEM DESCRIPTION (EA) (3)

Indicating/Warning (continued)

Components - Engine Left Side

Oil level sensor:
- Attached to the top of the oil tank at 9:30.

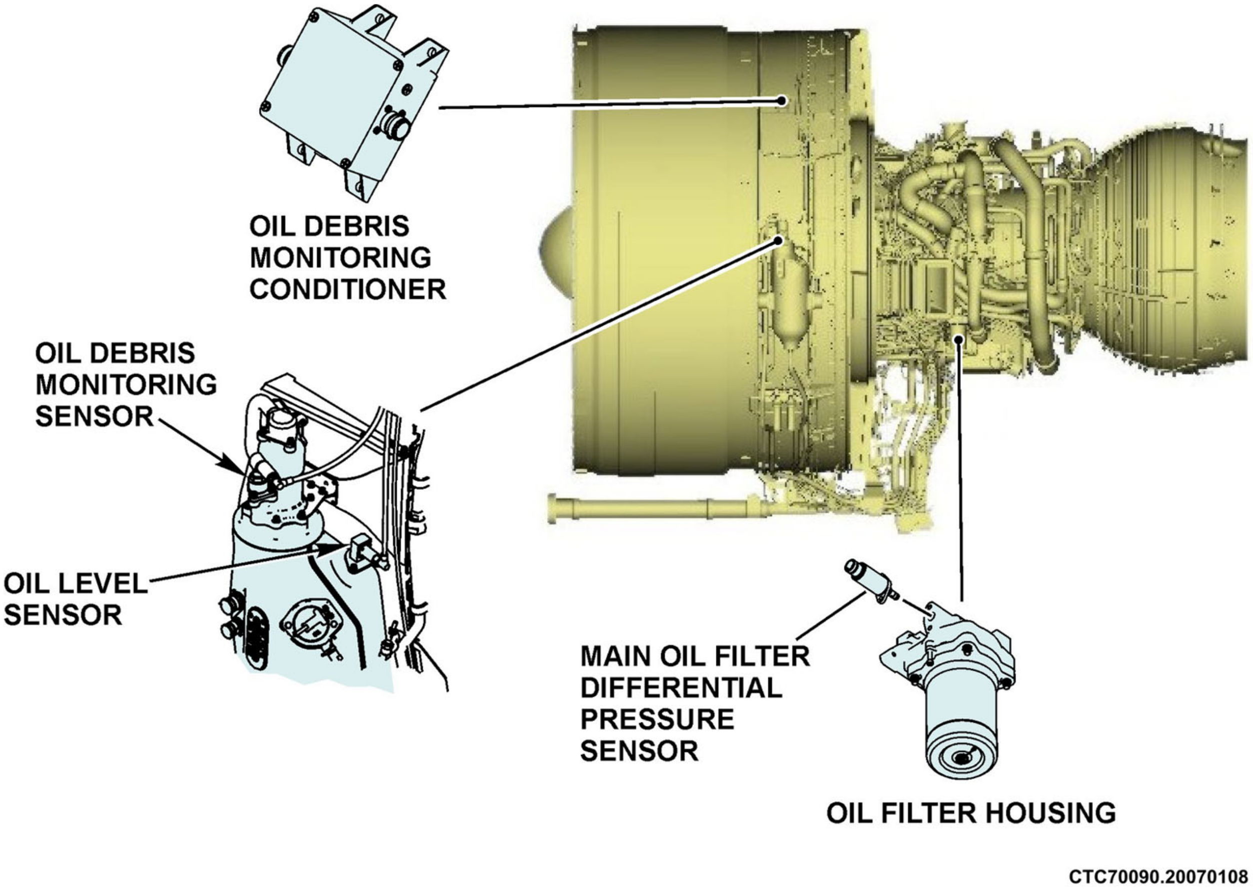
Main oil filter differential pressure sensor:
- Attached to the main oil filter housing at 8:00 o'clock.

Oil Debris Monitoring (ODM) sensor:
- Attached to the air/oil separator at 9:30.

Oil Debris Monitoring (ODM) conditioner:
- Attached to the rear fan case at 11:00 o'clock.

LRUs

Oil level sensor,
Main oil filter differential pressure sensor,
Oil debris monitoring sensor,
Oil debris monitoring conditioner.


OIL DEBRIS MONITORING CONDITIONER
OIL DEBRIS MONITORING SENSOR
OIL LEVEL SENSOR
MAIN OIL FILTER DIFFERENTIAL PRESSURE SENSOR
OIL FILTER HOUSING
CTC70090.20070108

INDICATION AND WARNING - ENGINE LEFT SIDE

INDICATING/WARNING - COMPONENTS - ENGINE LEFT SIDE & LRUS

ENGINE SERVICING (2)

Working Area

Engine Not Running

Even if the engine is not running, the area is still dangerous and the personnel has to obey the precautions, which are given to operate an engine safely.

Engine Running

To enable personnel safety when he has to act exceptionally on a running engine, the power level must be kept to the necessary minimum by setting thrust levers to the IDLE position.
The restricted areas are:
- the intake suction area: in a radius of 4.6 m (15 ft),
- the exhaust danger area: a corridor of 48° from the exhaust nozzles to 41.3 m (118 ft) afterwards.

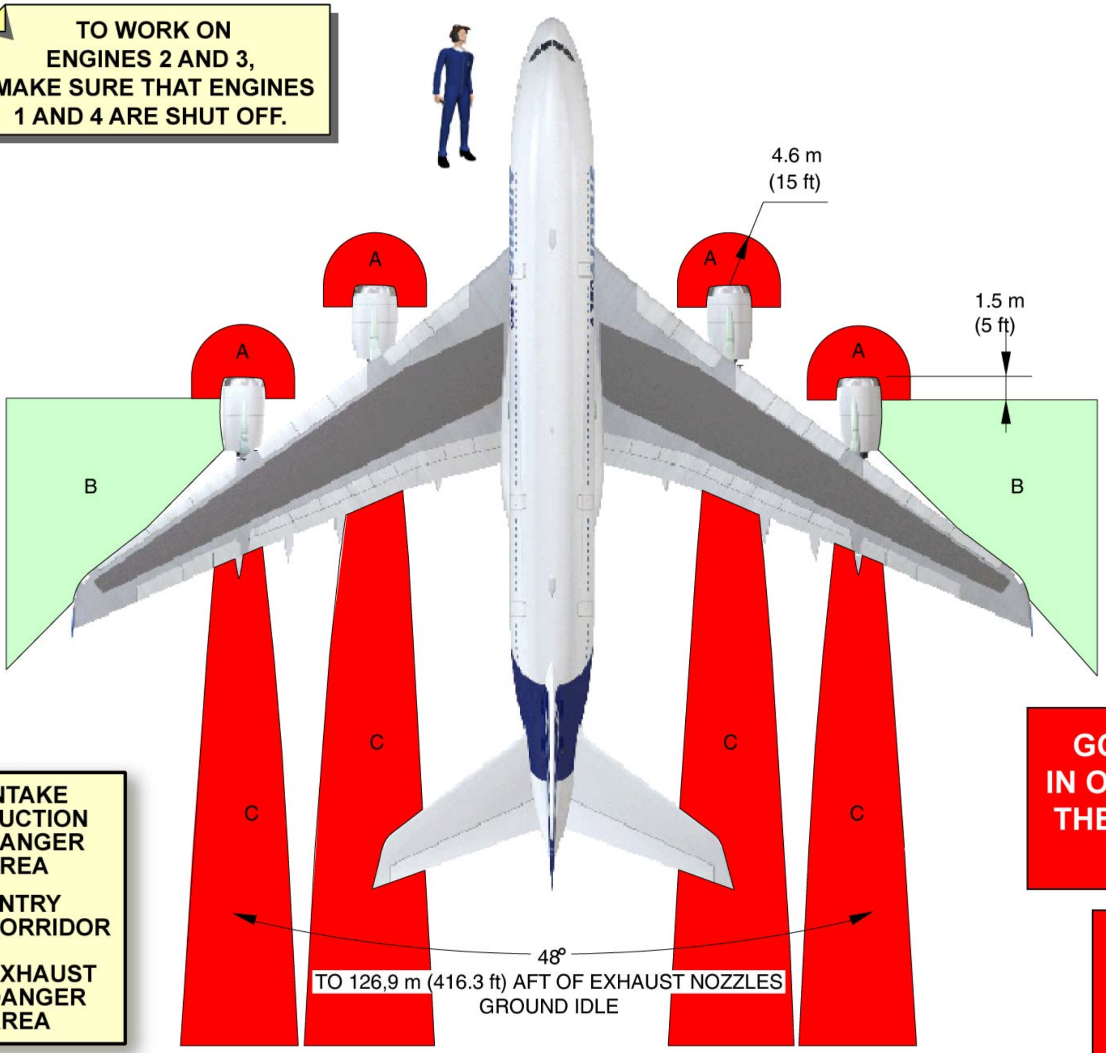
To work on the engine safely, you must use the entry corridors located at the engine outboard side 1.5 m (5 ft) aft of the air intake cowl.

NOTE: To work on the inboard engines, the outboard engines must be shut off first.

Human factor points:

WARNING: - BE CAREFUL WHEN YOU DO WORK ON THE ENGINE PARTS AFTER THE ENGINE IS SHUTDOWN. THE ENGINE PARTS CAN STAY HOT FOR ALMOST 1 HOUR.
- UNDER NORMAL CONDITIONS, EXCEPT IN THE ASSISTED MANUAL START SEQUENCE, THERE IS NO NEED AND IT IS NOT ALLOWED TO DO MAINTENANCE TASKS ON A RUNNING ENGINE.
- DO NOT GO NEAR AN ENGINE THAT IS IN OPERATION ABOVE LOW IDLE. IF YOU DO, IT CAN CAUSE AN INJURY. GO NEAR AN ENGINE IN OPERATION THROUGH THE ENTRY CORRIDORS ONLY.

TO WORK ON
ENGINES 2 AND 3,
MAKE SURE THAT ENGINES
1 AND 4 ARE SHUT OFF.


4.6 m
(15 ft)
A
A
A
A
1.5 m
(5 ft)
B
B
C
C
C
C
48°
TO 126,9 m (416.3 ft) AFT OF EXHAUST NOZZLES
GROUND IDLE

THROTTLE
CONTROL
LEVERS
ON IDLE
POSITION

NO MAINTENANCE
TASK IS ALLOWED
ON A RUNNING
ENGINE

GO NEAR AN ENGINE
IN OPERATION THROUGH
THE ENTRY CORRIDORS
ONLY

ENGINE PARTS
CAN STAY HOT FOR
ALMOST 1 HOUR

A	INTAKE SUCTION DANGER AREA
B	ENTRY CORRIDOR
C	EXHAUST DANGER AREA

WORKING AREA - ENGINE NOT RUNNING & ENGINE RUNNING

ENGINE SERVICING (2)

Drain System

The powerplant drains system can be divided into four types of drains:
- fuel,
- oil,
- hydraulic and,
- the others.

The drained fluids exit via a drain mast that is mounted on the rear face of the external gearbox at the split line between the two fan cowl doors.

Fuel System Drains

Drain lines take fuel from:
- Variable Stator Vane (VSV) right
- Start Bleed Valve
- Low Pressure Turbine Active Clearance Control (LPTACC)
- VSV left
- High Pressure Turbine Active Clearance Control (HPTACC)
- 2.5 bleed
- Main Fuel Pump: fuel and oil

The drain lines are separated to get easy troubleshooting.

Oil System Drains

Drain lines take oil from:
- N°3 bearing
- Engine Driven Pump (EDP) 1 & 2: oil + hydraulic fluid
- Main Fuel Pump
- Air oil separator
- After and forward pylon: oil + hydraulic fluid + condensation water

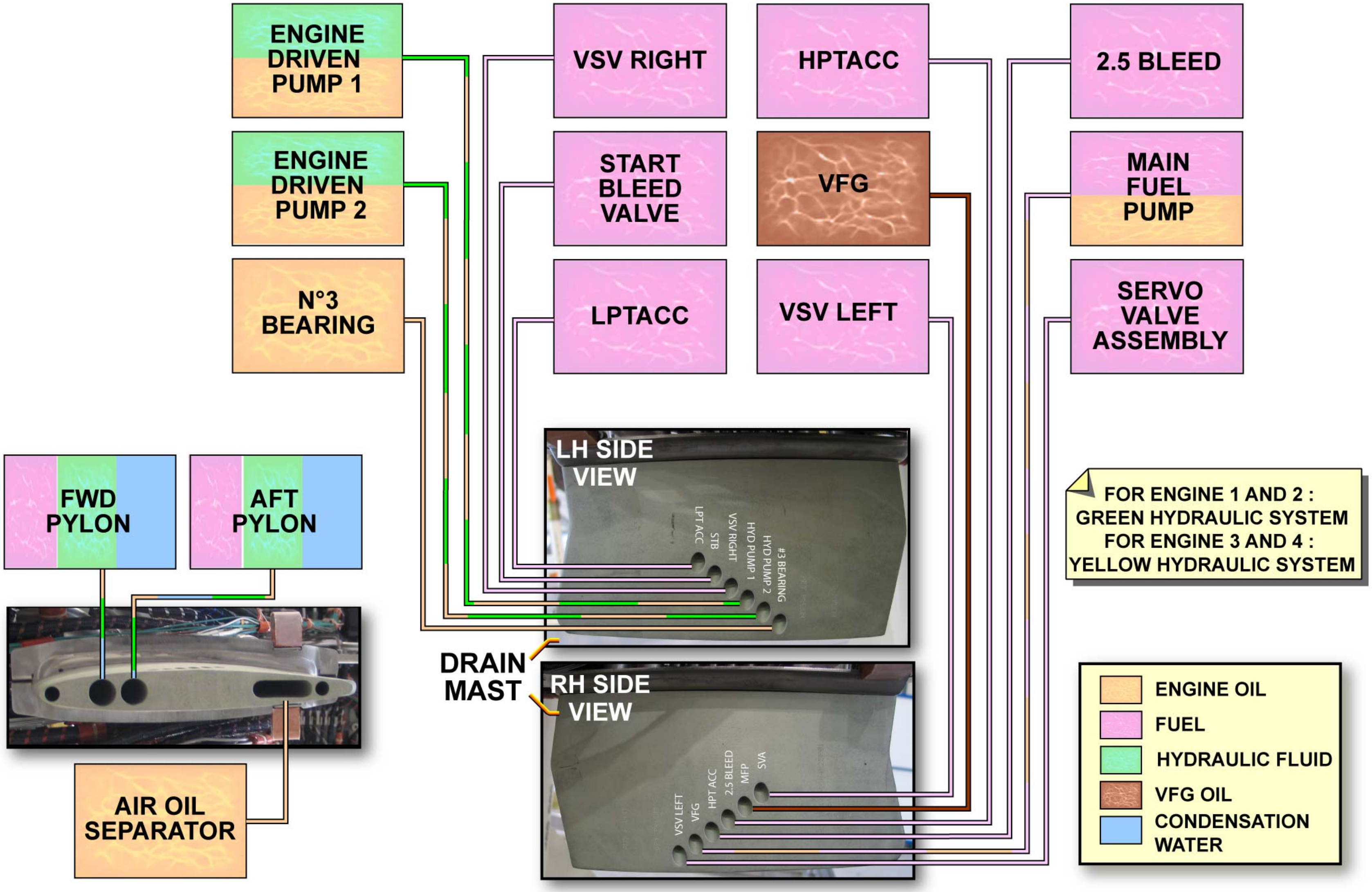
Hydraulic System Drains

Drain lines take hydraulic fluid from:
- Engine Driven Pump (EDP) 1 & 2: hydraulic fluid + oil
- After and forward pylon: hydraulic fluid + fuel + condensation water

Leakage Rates

To be sure that an engine operates correctly, the leakage rates at drain mast have to be monitored, checked and measured. The leakage rates for each system have to be within the acceptable limits specified by the engine manufacturer. If this is not the case, further troubleshooting is necessary to identify the source of the leak.

NOTE: Refer to AMM to deal with the leakage rates.



ENGINE DRIVEN PUMP 1

ENGINE DRIVEN PUMP 2

N°3 BEARING

VSV RIGHT

START BLEED VALVE

LPTACC

HPTACC

VFG

VSV LEFT

2.5 BLEED

MAIN FUEL PUMP

SERVO VALVE ASSEMBLY

FWD PYLON

AFT PYLON

AIR OIL SEPARATOR

DRAIN MAST

LH SIDE VIEW

RH SIDE VIEW

FOR ENGINE 1 AND 2 :
GREEN HYDRAULIC SYSTEM
FOR ENGINE 3 AND 4 :
YELLOW HYDRAULIC SYSTEM

🟧 ENGINE OIL
🟪 FUEL
🟩 HYDRAULIC FLUID
🟫 VFG OIL
🟦 CONDENSATION WATER

LPT ACC
STB
VSV RIGHT
HYD PUMP 1
HYD PUMP 2
#3 BEARING
VSV LEFT
VFG
HPT ACC
2.5 BLEED
MFP
SVA

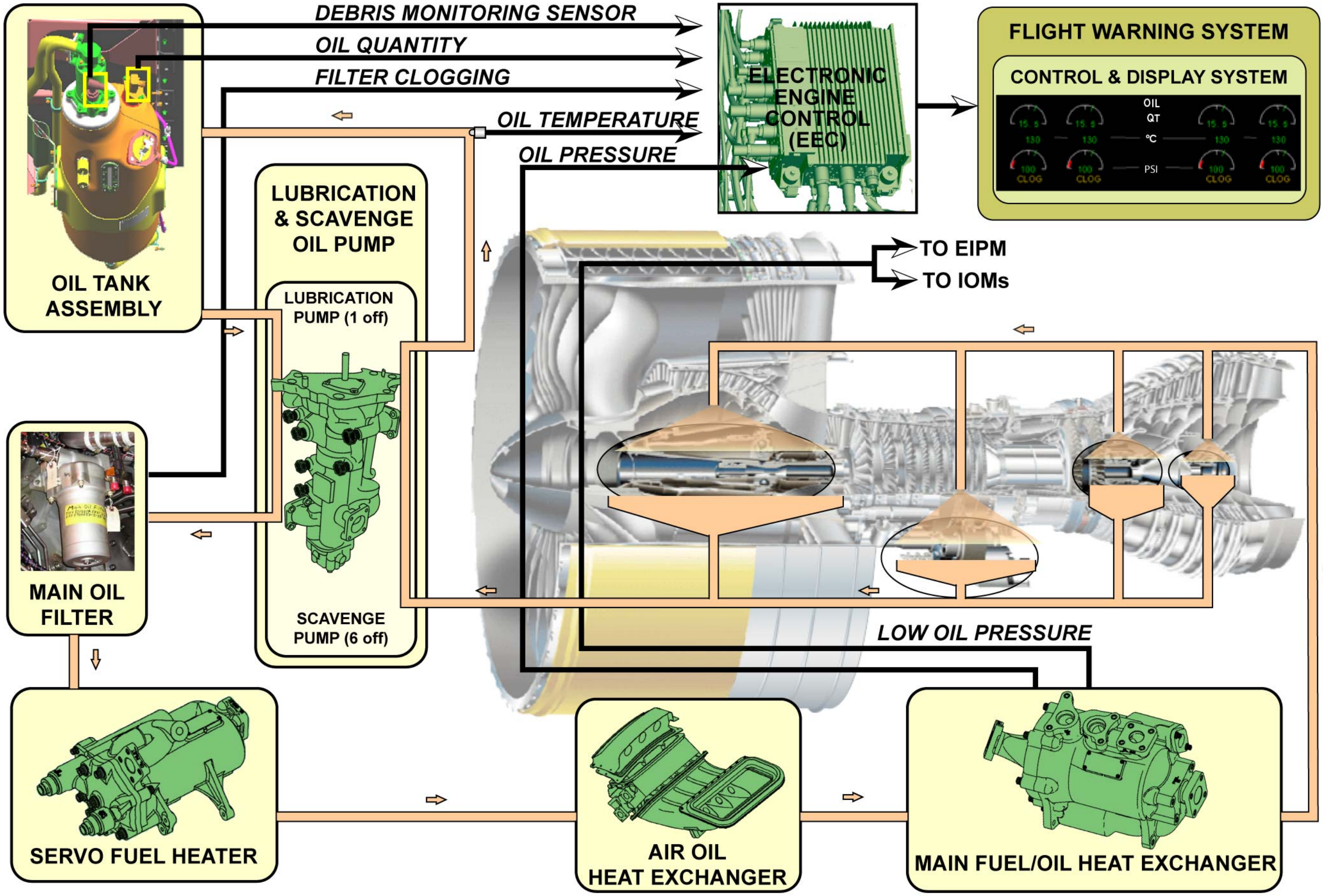
DRAIN SYSTEM - FUEL SYSTEM DRAINS ... LEAKAGE RATES

ENGINE SERVICING (2)

Engine Oil

System Architecture

The engine oil system is used to lubricate and cool the engine internal drives, gears and bearings. The system is composed of:
- An oil tank used for the storage of the oil,
- A lubrication and six scavenge oil pump units, which supply pressure to move the oil to or from the drives, gears and bearings,
- A main oil filter, which avoids unwanted particles.
-Two fuel oil heat exchangers, which decrease the oil temperature and increase the fuel temperature (the servo fuel heater and the main fuel oil heat exchanger).
- An air Oil Heat Exchanger that decrease the oil temperature.
The Electronic Engine Control (EEC) monitors the main oil parameters:
Oil quantity
Oil pressure
Oil temperature
Filter clogging
Low pressure detection via the EIPM and the IOMs
Oil debris monitored by the oil debris monitoring sensor.
These parameters are monitored in the Cockpit Display System (CDS): EWD and SD.


OIL TANK ASSEMBLY
DEBRIS MONITORING SENSOR
OIL QUANTITY
FILTER CLOGGING
OIL TEMPERATURE
OIL PRESSURE
ELECTRONIC ENGINE CONTROL (EEC)
FLIGHT WARNING SYSTEM
CONTROL & DISPLAY SYSTEM
OIL
QT
°C
PSI
15.5
130
100
CLOG
LUBRICATION & SCAVENGE OIL PUMP
LUBRICATION PUMP (1 off)
SCAVENGE PUMP (6 off)
TO EIPM
TO IOMs
MAIN OIL FILTER
LOW OIL PRESSURE
SERVO FUEL HEATER
AIR OIL HEAT EXCHANGER
MAIN FUEL/OIL HEAT EXCHANGER

ENGINE OIL - SYSTEM ARCHITECTURE

LB408521 - L5CT0T0 - LM7EDVLEVEL0201

ENGINE SERVICING (2)

Engine Oil (continued)

Servicing

The engine oil servicing is done by the filling of the engine oil system with approved oil and by inspecting the system in order to find and correct the engine oil contamination.

Inspection of the main oil filter element

To examine the main oil filter element, it must be removed first. The presence of magnetic particles has to be detected and these particles have to be removed. The filter and the filter housing have to be cleaned if magnetic particles are found in the filter; the Oil Debris Monitoring (ODM) sensor also has to be examined. After examination of the particles, the filter and its seal have to be replaced by new ones. The fuel and oil leak check on the scavenge filter housing is required before putting the aircraft back into operation.

Inspection of the Oil Debris Monitoring sensor

To examine the Oil Debris Monitoring sensor, it must be removed first. The presence of particles has to be detected and these particles have to be removed. The detector and the particles are examined. After examination of the particles, the detector can be re-installed. The preformed packing and the omniseal have to be replaced if they are found damaged. The oil leak check on the detector housing is required before putting the aircraft back into operation.

Inspection of the magnetic chip collectors

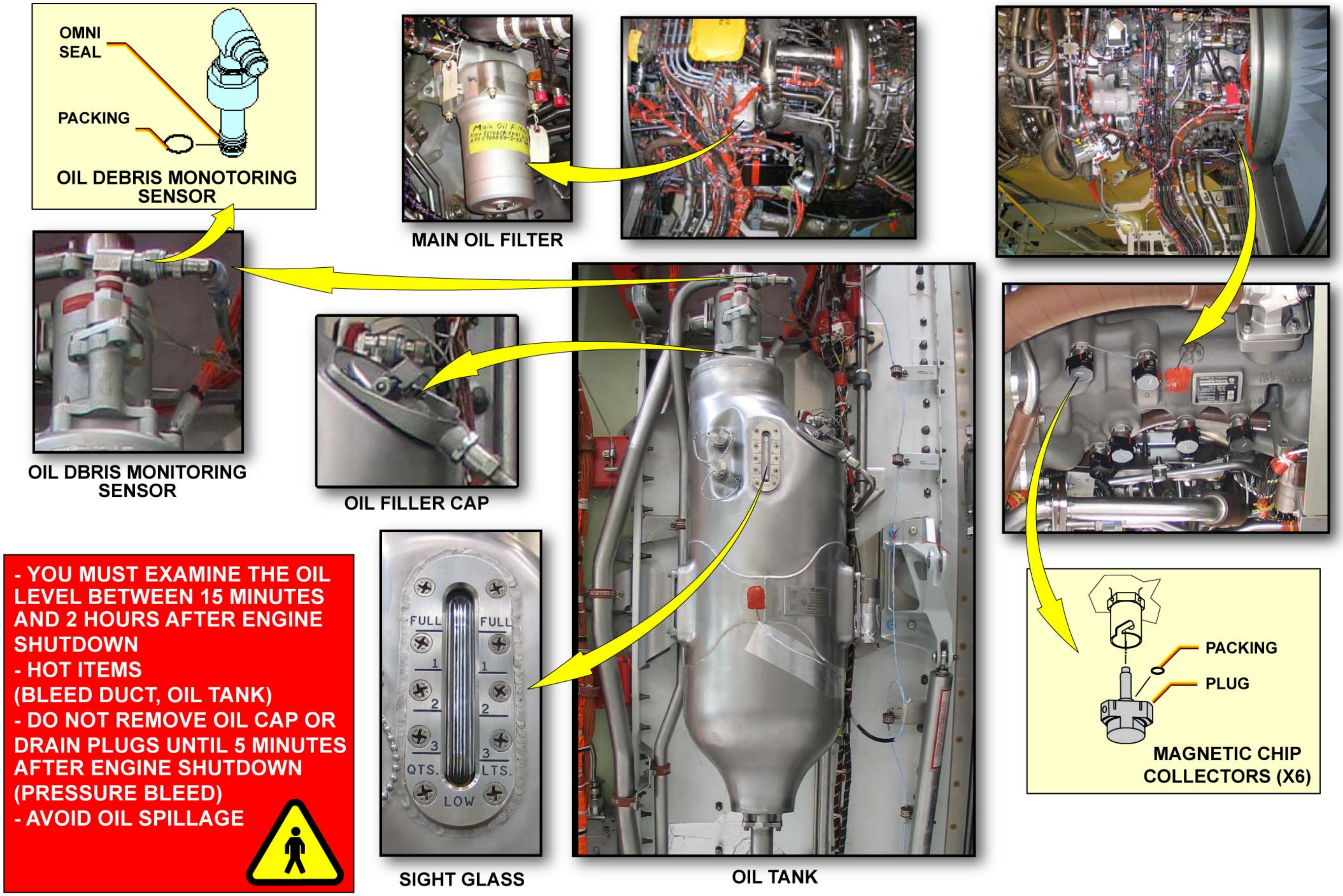
If you find particles on the ODM you must check the six magnetic chip collector located on the oil pump.
To examine the magnetic chip collectors, they must be removed first. The presence of particles has to be detected and these particles have to be removed. The collectors and the particles are examined. After examination of the particles, the collectors can be re-installed but the packing have to be replaced by new one. The oil leak check on the plug is required before putting the aircraft back into operation.

Refill of engine oil tank

Before replenishing the oil tank, a visual check of the engine oil level in the sight glass of the oil tank must be done. You must examine the oil level between 15 minutes and 2 hours after engine shutdown. If you exceed this time, it is necessary to dry motor the engine before refilling the oil tank. To refill the tank, the oil filler cap is removed and the engine lubricating oil Mobil Jet II is added. The check for fuel fumes in the tank is required before putting the aircraft back into operation.
Human factor points:

WARNING: - BE CAREFUL, THE ENGINE PARTS (BLEED DUCT, OIL TANK) CAN STAY HOT FOR ALMOST 1 HOUR AFTER SHUTDOWN.
-DO NOT REMOVE THE OIL TANK CAP OR DRAIN PLUGS UNTIL 5 MINUTES MINIMUM AFTER THE ENGINE SHUTDOWN. THIS WILL LET THE PRESSURE BLEED OFF. IF YOU DO NOT OBEY THIS WARNING, HOT OIL CAN BURN YOUR EYES AND YOUR SKIN.

CAUTION: -YOU MUST EXAMINE THE OIL LEVEL BETWEEN 15 MINUTES AND 2 HOURS AFTER THE ENGINE SHUTDOWN .IF YOU DO NOT, THE OIL LEVEL SIGHTGLASS INDICATION WILL NOT BE ACCURATE.
- AVOID SPILLAGE WHEN SERVICING OIL.


OMNI SEAL
PACKING
OIL DEBRIS MONOTORING SENSOR
MAIN OIL FILTER
OIL DBRIS MONITORING SENSOR
OIL FILLER CAP
FULL
FULL
1
1
2
2
3
3
QTS.
LTS.
LOW
SIGHT GLASS
OIL TANK
PACKING
PLUG
MAGNETIC CHIP COLLECTORS (X6)

- YOU MUST EXAMINE THE OIL LEVEL BETWEEN 15 MINUTES AND 2 HOURS AFTER ENGINE SHUTDOWN
- HOT ITEMS
(BLEED DUCT, OIL TANK)
- DO NOT REMOVE OIL CAP OR DRAIN PLUGS UNTIL 5 MINUTES AFTER ENGINE SHUTDOWN
(PRESSURE BLEED)
- AVOID OIL SPILLAGE

ENGINE OIL - SERVICING

ENGINE IGNITION SYSTEM (EA) (3)

General Overview

Purpose

The ignition system provides an electrical spark to start the engine combustion process, and in some phases of operation to help sustain the combustion process.

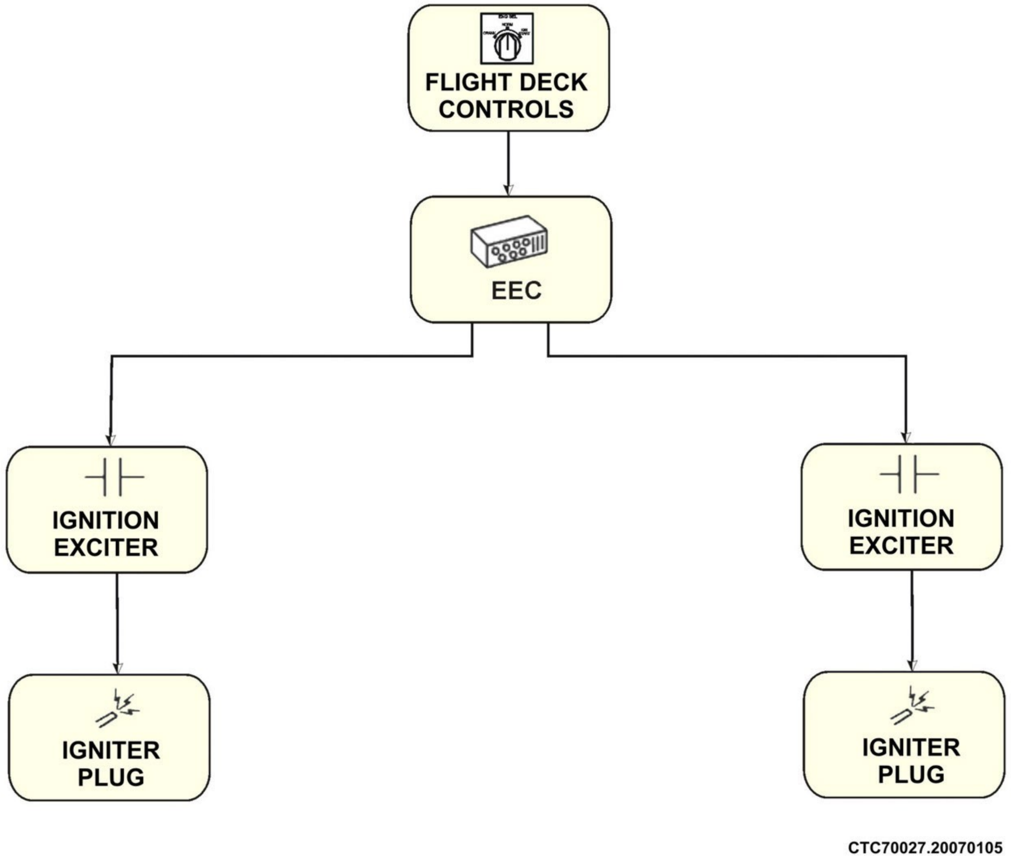
Subsystems

Ignition power supply,
High voltage distribution.

Description

There are two independent, redundant systems on each engine:
- System A (1),
- System B (2).

They are used for starting the engine on the ground and in the air, for both manual and auto start modes,
The systems are designed for continuous duty operation.


FLIGHT DECK CONTROLS
EEC
IGNITION EXCITER
IGNITION EXCITER
IGNITER PLUG
IGNITER PLUG
CTC70027.20070105

GENERAL OVERVIEW - PURPOSE ... DESCRIPTION

ENGINE IGNITION SYSTEM (EA) (3)

Ignition Power Supply

Purpose

The ignition exciters change 115 VAC aircraft electrical power to the high voltage (15,000 to 19,000 volts) necessary for igniter plug operation.

Components

Ignition exciters:
- Attached by anti-shock mounts to the fan case at 3 o'clock.

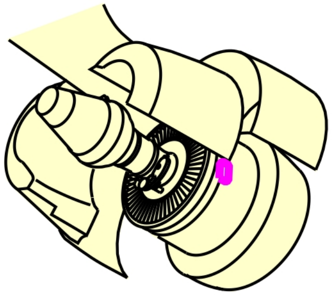
Description and Operation

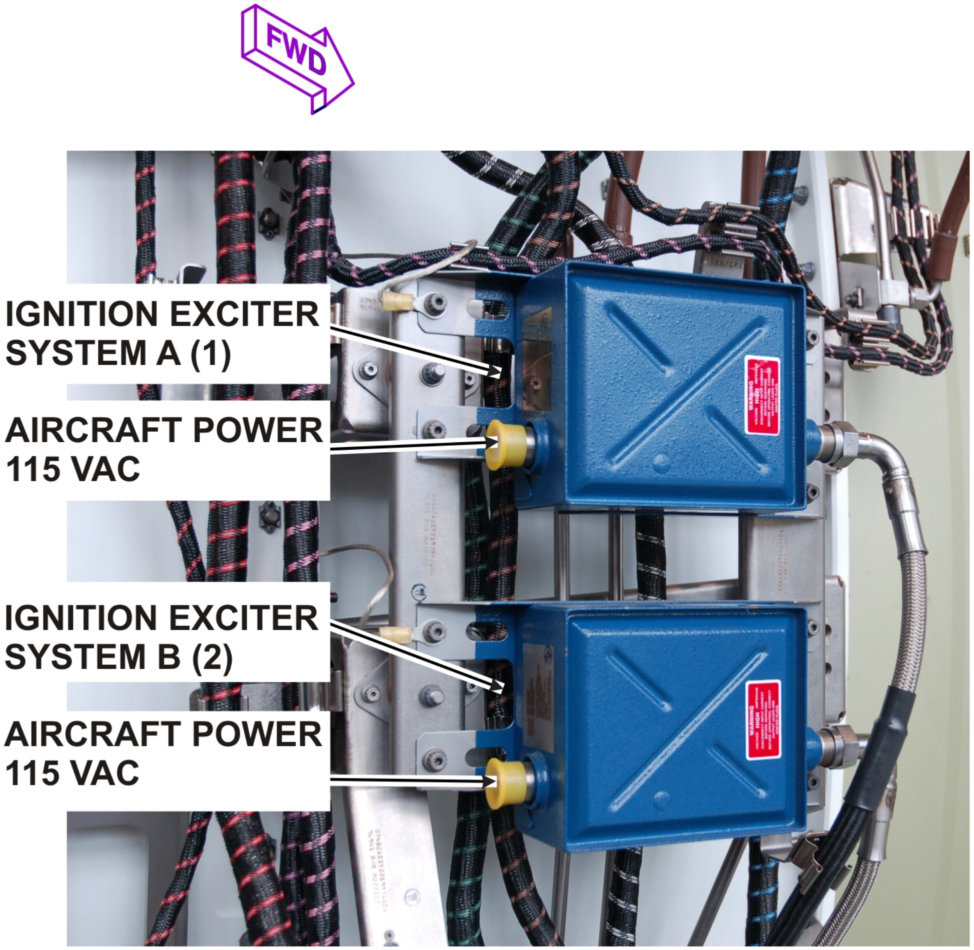
The ignition exciters are hermetically sealed, capacitor discharge components that are powered from two independent 115 VAC supply lines from the airframe via relays in the EEC:
- Ignition exciter A (1) is powered from the essential bus,
- Ignition exciter B (2) is powered from the normal bus.

Each exciter operates at 300 to 800 Hz.
The minimum energy delivered at the igniter plug tip is 1.5 joules.

LRUs

Ignition exciters.




FWD
IGNITION EXCITER SYSTEM A (1)
AIRCRAFT POWER 115 VAC
IGNITION EXCITER SYSTEM B (2)
AIRCRAFT POWER 115 VAC

CTC70202.20070918

IGNITION POWER SUPPLY - PURPOSE ... LRUS

ENGINE IGNITION SYSTEM (EA) (3)

High Voltage Distribution

Purpose

The high voltage distribution subsystem transfers high-voltage power from the ignition exciters through ignition leads to the igniter plugs.

Components

Ignition leads:
- Connected at one end to the ignition exciters and, at the other end to the igniter plugs.

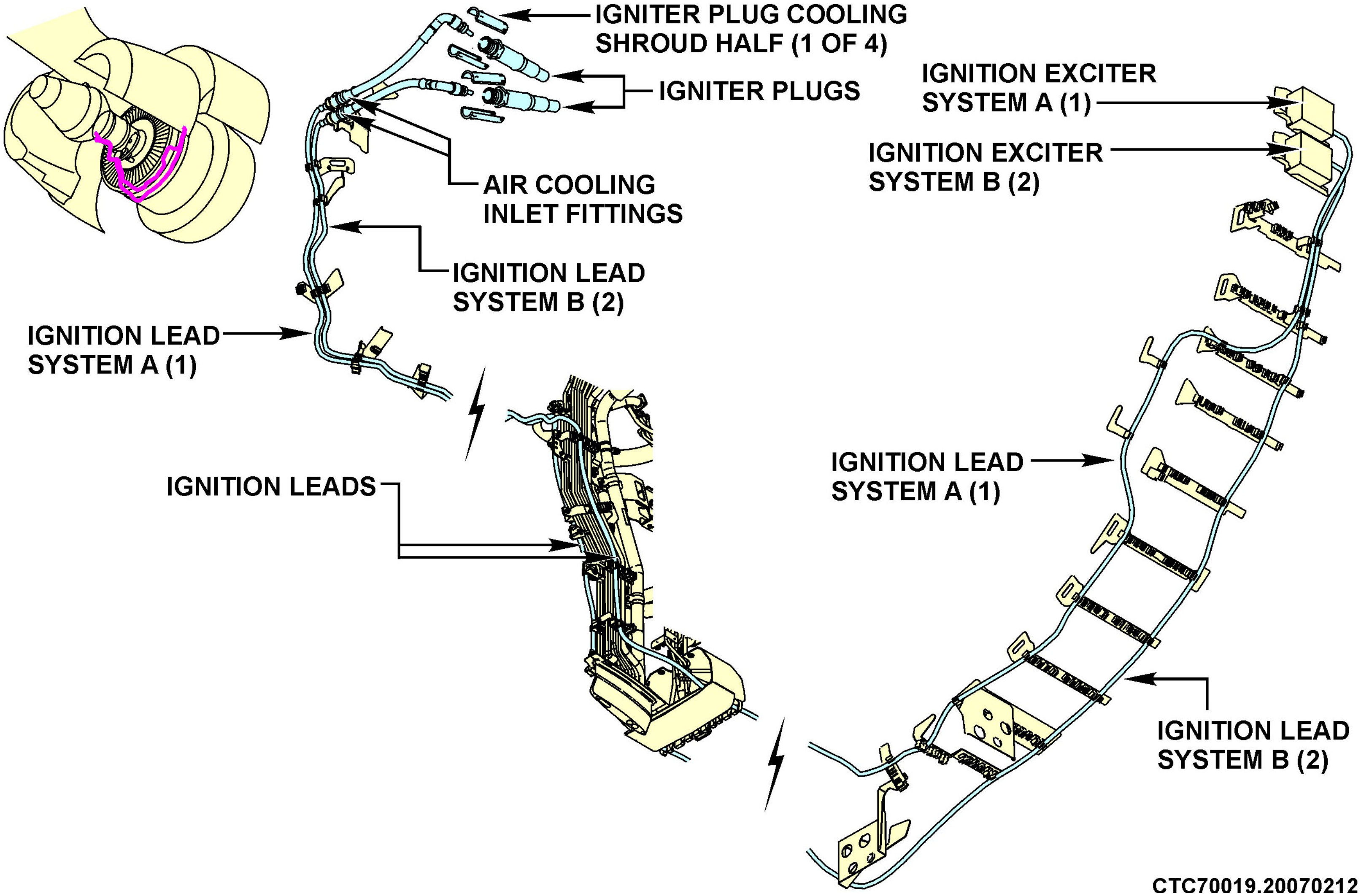
Igniter plugs:
- Attached to the Combustor Diffuser Nozzle (CDN) case at 8 o'clock and 9 o'clock.

Description and Operation

The ignition leads transfer the high electrical energy from the ignition exciters to the igniter plugs.
The igniter plugs use the high-energy ignition exciter output to arc across the plug-firing gap creating a spark.
The spark is used to ignite the fuel/air mixture.
The ignition leads are fan air cooled on the end which connects to the igniter plug. Cooling shrouds integrated into the ignition leads have connections that receive cooling air from the core compartment cooling system.

LRUs

Ignition leads,
Igniter plugs,
Cooling shrouds.


IGNITER PLUG COOLING SHROUD HALF (1 OF 4)
IGNITER PLUGS
IGNITION EXCITER SYSTEM A (1)
IGNITION EXCITER SYSTEM B (2)
AIR COOLING INLET FITTINGS
IGNITION LEAD SYSTEM B (2)
IGNITION LEAD SYSTEM A (1)
IGNITION LEADS
IGNITION LEAD SYSTEM A (1)
IGNITION LEAD SYSTEM B (2)

CTC70019.20070212

HIGH VOLTAGE DISTRIBUTION - PURPOSE ... LRUS

ENGINE IGNITION SYSTEM (EA) (3)

Power Supply And High Voltage Distribution

Description and Operation

Each engine has two independent ignition systems {System A (1) and System B (2)]:
- The systems can be used at the same time or used alternately,
- Both systems are used for manual starts, auto-restarts, and in-flight starts,
- Continuous ignition is flight deck selectable.

Ignition system control is integrated with the starter and engine fuel shutoff control to permit automatic start sequencing managed by the EEC.

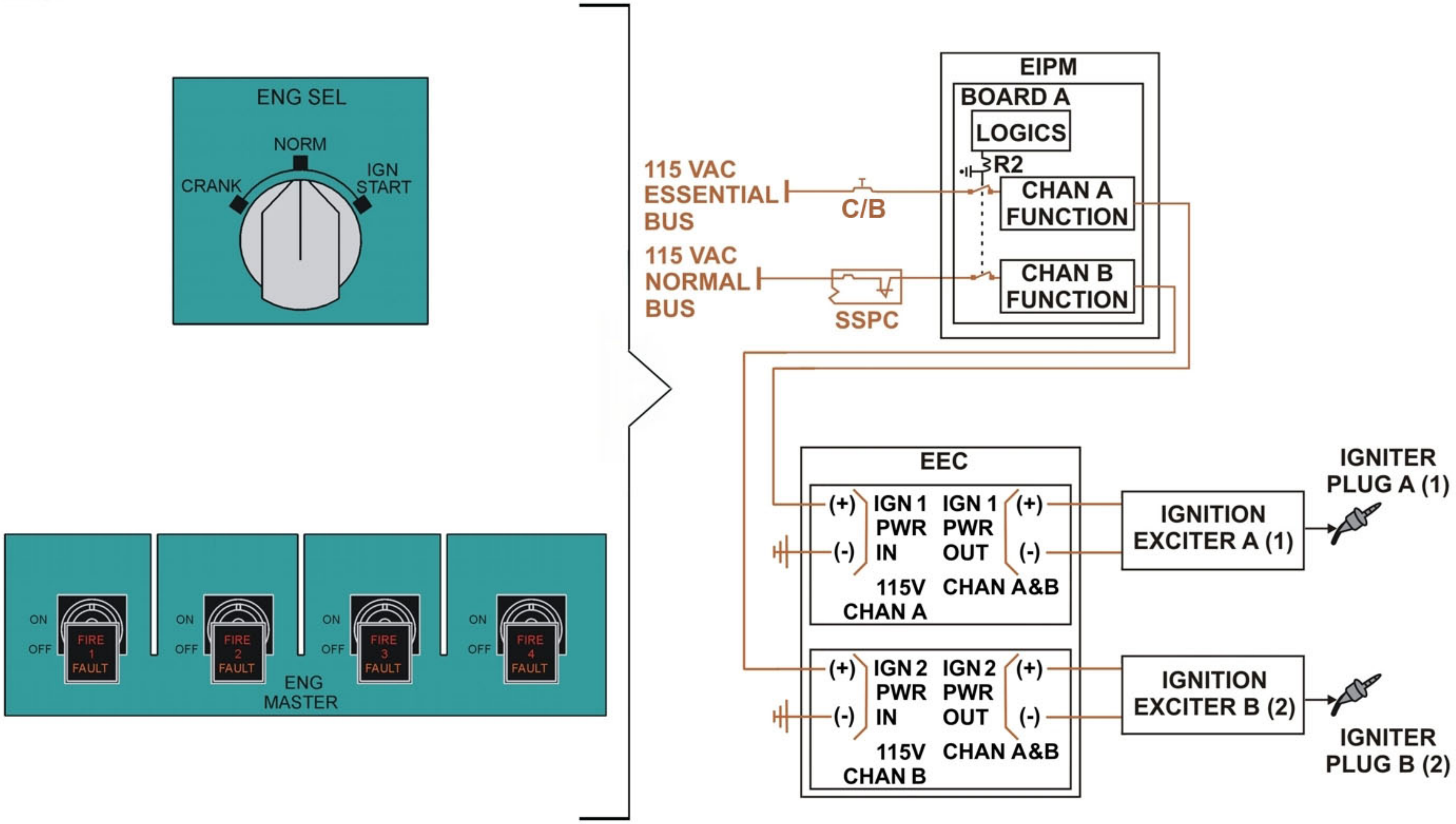
115 VAC aircraft power is sent to the ignition exciter via relays in the EIPM and the EEC.

The auto relight function in the EEC will energize both ignition systems if a flameout is detected by the FADEC system.

During an autostart on the ground, the EEC selects one exciter system for two successive starts. Then for the next two successive starts the other exciter system will be selected.

Ignition Sequencing

Start Event: 1,
EEC Channel: A,
Igniter Fired: No. 1.
- Start Event: 2,
EEC Channel: B,
Igniter Fired: No. 1.
- Start Event: 3,
EEC Channel: A,
Igniter Fired: No. 2.
- Start Event: 4,
EEC Channel: B,
Igniter Fired: No. 2.


ENG SEL
NORM
CRANK
IGN START
ON
OFF
FIRE 1 FAULT
FIRE 2 FAULT
FIRE 3 FAULT
FIRE 4 FAULT
ENG MASTER
115 VAC ESSENTIAL BUS
C/B
115 VAC NORMAL BUS
SSPC
EIPM
BOARD A
LOGICS
R2
CHAN A FUNCTION
CHAN B FUNCTION
EEC
(+) IGN 1 PWR IN
(-)
115V CHAN A
IGN 1 PWR OUT (+) (-)
CHAN A&B
(+) IGN 2 PWR IN
(-)
115V CHAN B
IGN 2 PWR OUT (+) (-)
CHAN A&B
IGNITION EXCITER A (1)
IGNITION EXCITER B (2)
IGNITER PLUG A (1)
IGNITER PLUG B (2)

CTC70026.20081017

POWER SUPPLY AND HIGH VOLTAGE DISTRIBUTION - DESCRIPTION AND OPERATION & IGNITION SEQUENCING

ENGINE STARTING SYSTEM (EA) (3)

General Overview

Purpose

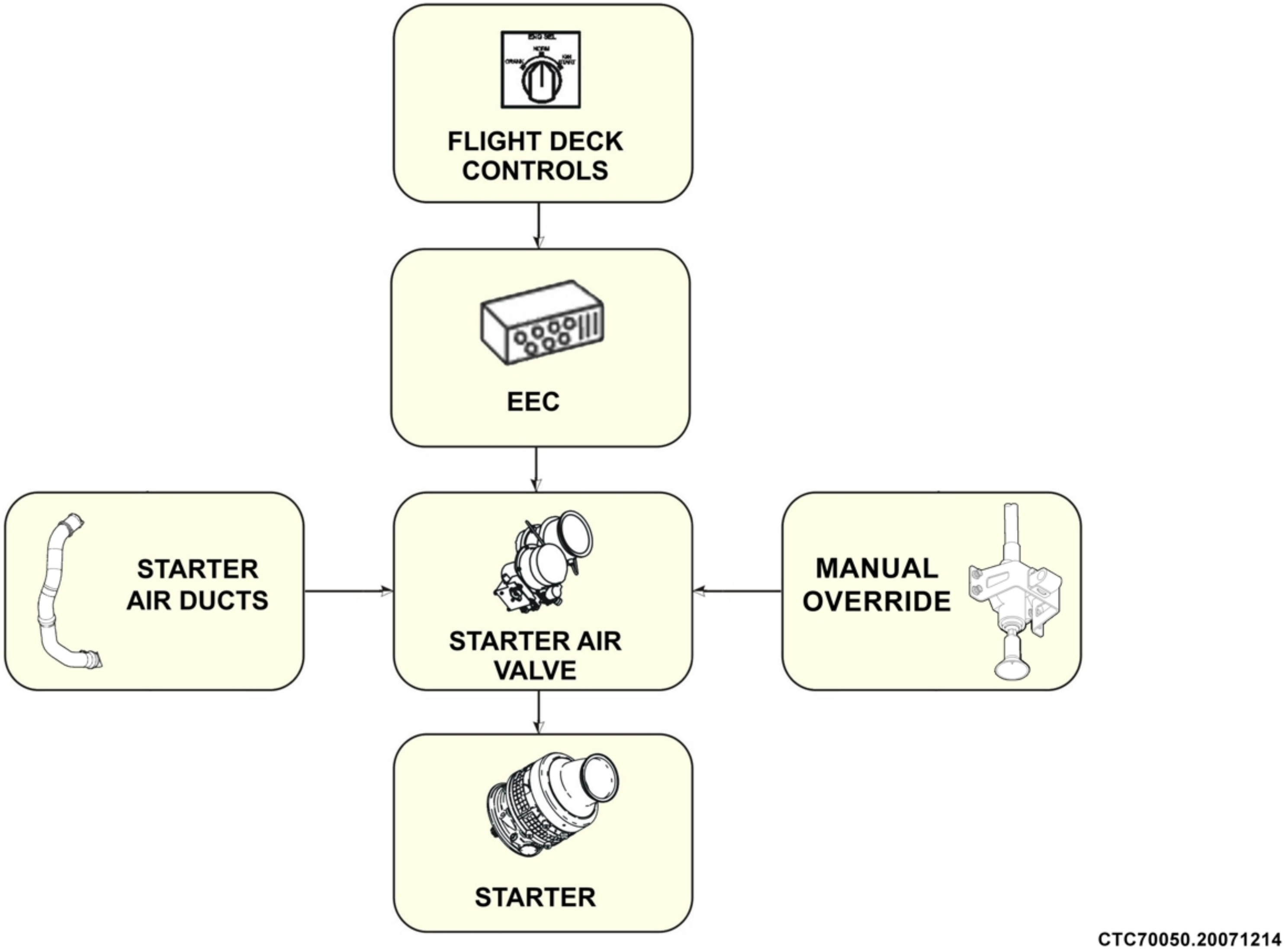
The starting system turns the core engine during an engine start to get sufficient air/fuel mixture and positive acceleration of the engine for ground starts and in-flight starts.
It also turns the core engine for engine motoring (cranking).

Components

Starter air supply ducts,
Starter air valve,
Starter.

Description and Operation

The Electronic Engine Control (EEC) controls the starting system functions based on cockpit Engine Start/Ignition panel and Engine Master lever inputs.


FLIGHT DECK CONTROLS
EEC
STARTER AIR DUCTS
STARTER AIR VALVE
MANUAL OVERRIDE
STARTER
CTC70050.20071214

GENERAL OVERVIEW - PURPOSE ... DESCRIPTION AND OPERATION

ENGINE STARTING SYSTEM (EA) (3)

Air Ducts & Starter Air Valve

Purpose

The air ducts direct the airflow to the starter.
The starter air valve controls the airflow to the starter.

Components

Starter stub duct:
- Located between the pylon air duct and the starter duct.

Starter air supply duct:
- Attached circumferentially to the left side of the combustor diffuser nozzle between 10 and 7 o'clock positions.

Starter air valve:
- Attached to the inlet of the starter at 6 o'clock.

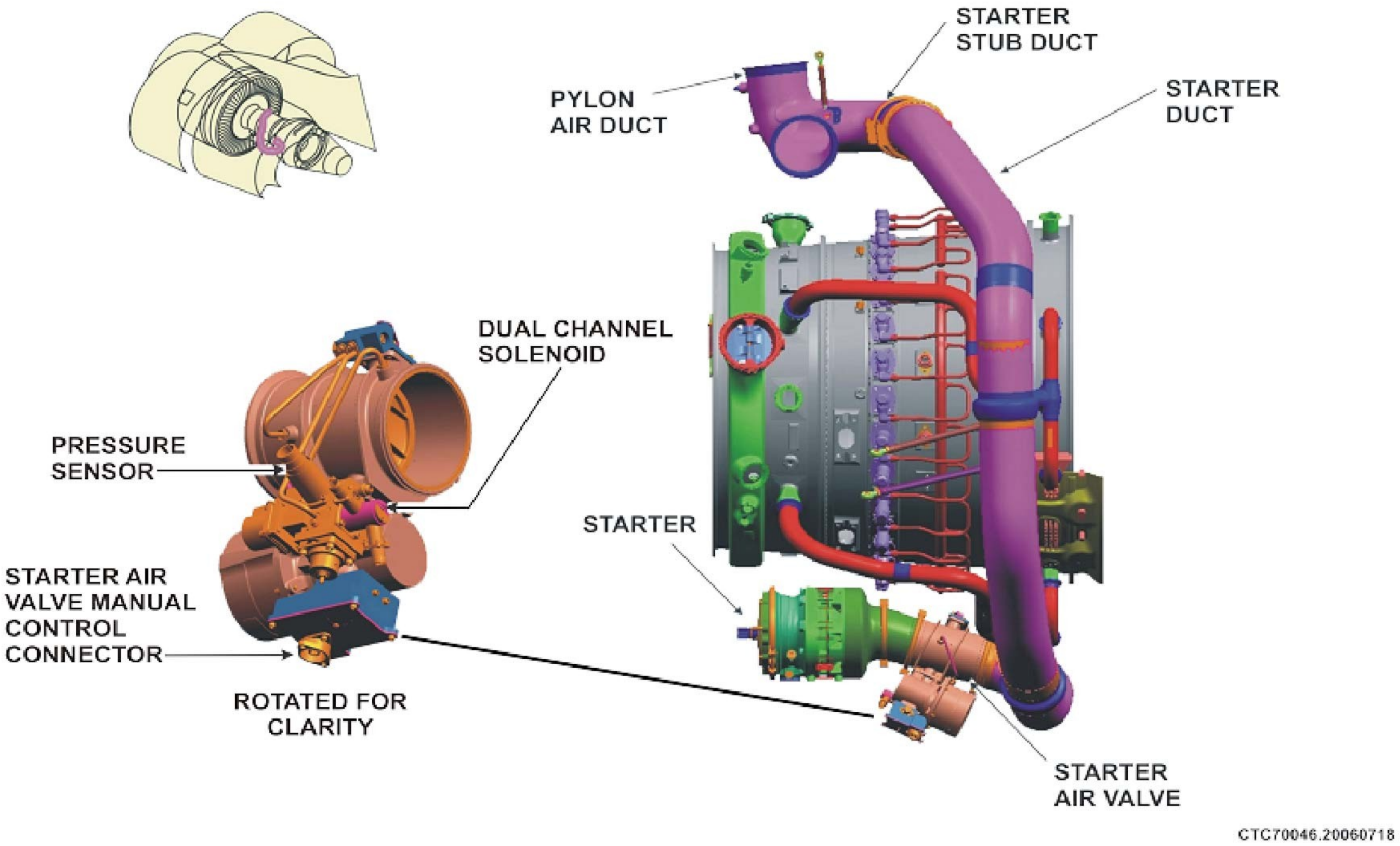
Starter air pressure sensor:
- Attached to the starter air valve.

Description

Air flows through the air supply ducts to the starter air valve.
The starter air valve controls the air flow to the starter.
The starter air valve can be manually opened and closed.
The starter air pressure sensor supplies starter air valve position signal to the EEC. The signal is used for starter air valve position detection and fault monitoring.
During engine start the starter air valve will close at 58.4% N2.

LRUs

Starter stub duct,
Starter duct,
Starter air valve,
Starter air pressure sensor.


STARTER
STUB DUCT
PYLON
AIR DUCT
STARTER
DUCT
DUAL CHANNEL
SOLENOID
PRESSURE
SENSOR
STARTER
STARTER AIR
VALVE MANUAL
CONTROL
CONNECTOR
ROTATED FOR
CLARITY
STARTER
AIR VALVE
CTC70046.20060718

AIR DUCTS & STARTER AIR VALVE - PURPOSE ... LRUS

ENGINE STARTING SYSTEM (EA) (3)

Starter

Purpose

The starter turns the core engine during an engine start and for engine motoring (cranking).

Components

Starter:
- Attached to the starter Quick Attach Detach (QAD) adapter on the rear of the main gearbox at 6 o'clock.

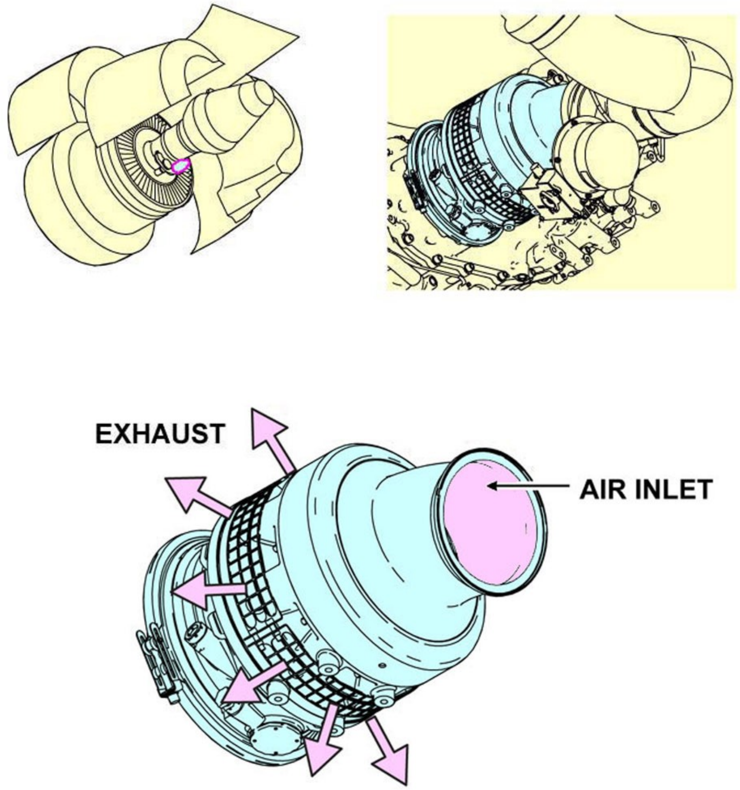
Starter QAD adapter:
- Attached to the rear of the main gearbox at 6 o'clock.

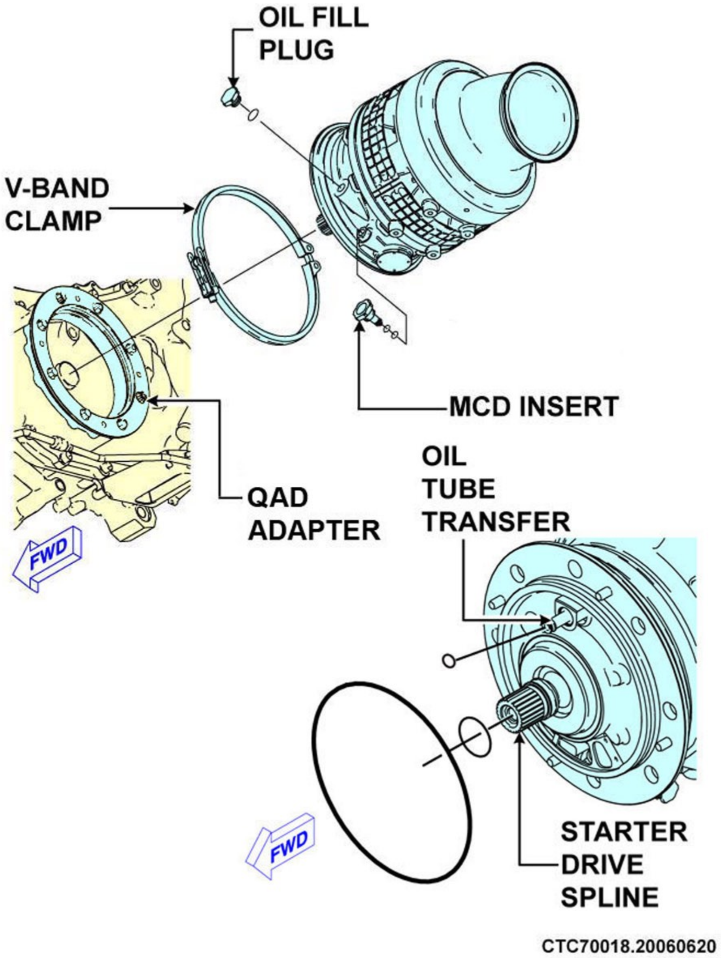
Description

The starter air turbine converts the pressurized airflow kinetic energy to mechanical energy to rotate the core engine assembly.

LRUs

Starter,
Starter QAD adapter,
Magnetic Chip Detector (MCD) insert,
Oil fill plug.


EXHAUST
AIR INLET


OIL FILL PLUG
V-BAND CLAMP
MCD INSERT
QAD ADAPTER
OIL TUBE TRANSFER
FWD
FWD
STARTER DRIVE SPLINE
CTC70018.20060620

STARTER - PURPOSE ... LRUS

ENGINE START / CRANK CONTROL DESCRIPTION (3)

Ignition and Starting System Description

The ignition and starting system has three subsystems:
- Starting,
- Fuel command,
- Ignition.

Starting

Engines can be started using the APU air bleed, or a ground air supply or cross bleed air from an operating engine.
The Electronic Engine Control (EEC) controls the opening and closing of the Starter Air Valve (SAV) in all start modes. The SAV controls the airflow to the pneumatic starter. The pneumatic starter drives N2 through the accessory gearbox.
Starter cycle runs:
- 5 minutes motoring
- 10 minutes cooling
- 5 minutes motoring
- 10 minutes cooling
- 5 minutes motoring
- 30 minutes cooling

Fuel command

The EEC controls, through the Fuel Metering Valve (FMV) servo valve, the FMV, which regulates the fuel flow to the manifolds.
The ENGine MASTER lever controls, through the A/C HPSOV solenoid, the closing of the PRESSure & Shut-OFF Valve (PRESS & S/O).
The Fuel Flow Transmitter (FF XMTR) sends its data to the EEC.

Ignition units power supply

The Engine Interface Power Management (EIPM) supplies power to the ignition exciters A and B through the EEC (channel A and B).
A/C BUS BAR 115 VAC EMERgency supplies EIPM ignitor A function.
EIPM Ignitor A function could supply Ignition unit A or B depending on the EEC switching.
A/C BUS BAR 115 VAC NORMal supplies EIPM ignitor B function.
EIPM Ignitor B function could supply Ignition unit A or B depending on the EEC switching.

EEC ignition units switching function:

Each EEC channel is able to control the switching of the power supply of the two ignition units A and B.
During an engine auto start on ground, the EEC controls automatically the switching of the ignition units A or B.
During an engine manual start, the EEC controls both ignition units A and B, for ignition efficiency.

NOTE: During Engine auto start in flight, both ignition units are energized, for redundancy.

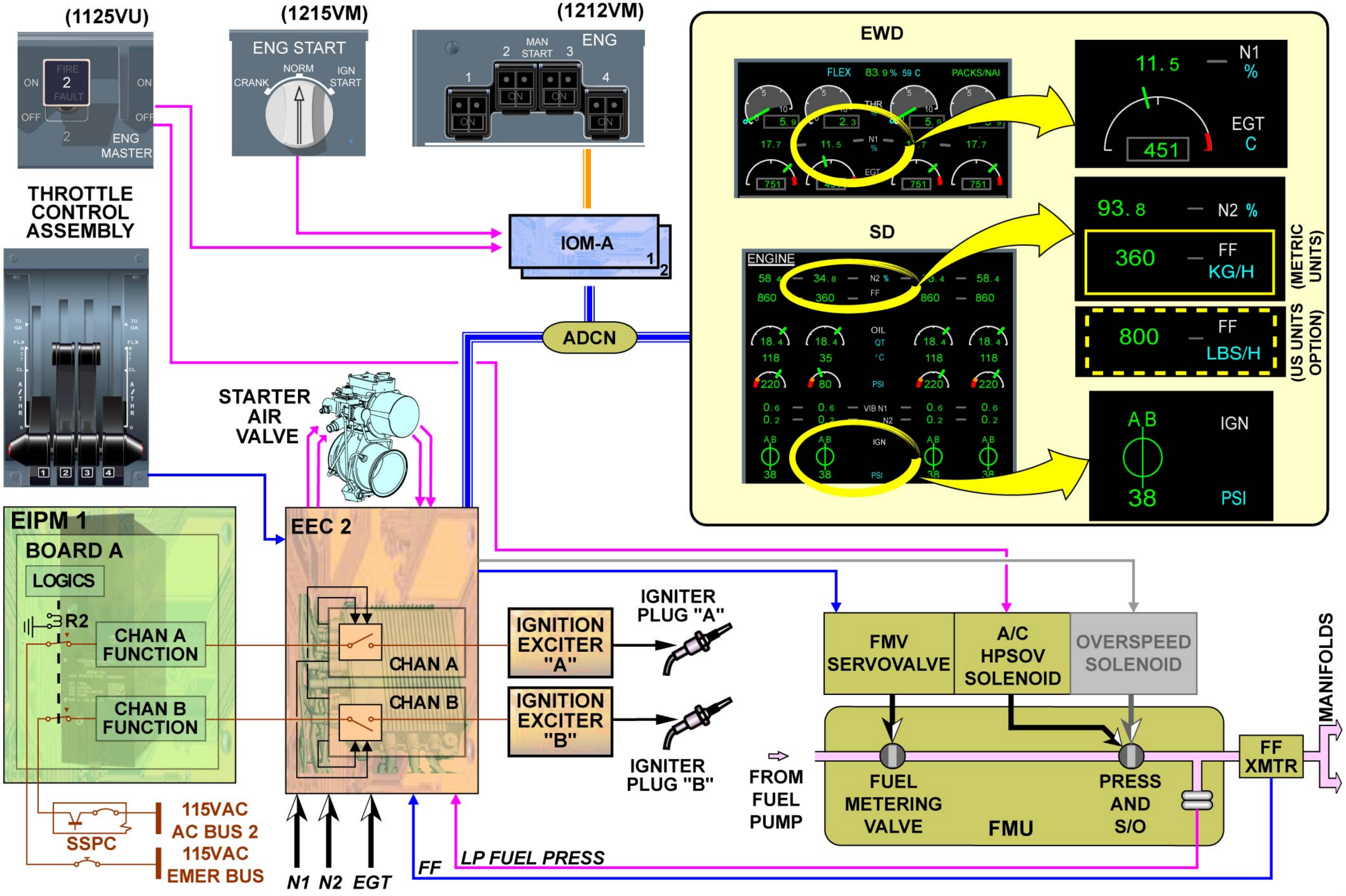
Controls from the cockpit

The engine start/crank is controlled from the cockpit by:
- ENGine rotary selector,
- ENGine MASTER levers,
- ENGine MANual START P/B SW,
- Throttle Control Assembly (TCA) to idle detent.

System functions

The engine can be started in two manners:
- Automatic start (normal procedure),
-Manual start (back-up procedure).
The engine can be cranked in two manners:
- Dry crank,
- Wet crank.
Auto-relight function:
- When a flame-out is detected the system energizes the two igniters.
Quick relight function (in flight only):

- if the ENG MASTER lever is inadvertently selected "OFF", the ENG MASTER lever can be selected "ON" again within 30 seconds to cancel the shutdown sequence.


(1125VU)
FIRE 2 FAULT
ON
OFF
ENG MASTER
(1215VM)
ENG START
CRANK
NORM
IGN START
(1212VM)
MAN START
ENG
1
2
3
4
ON
THROTTLE CONTROL ASSEMBLY
IOM-A
1
2
ADCN
STARTER AIR VALVE
EWD
SD
FLEX
83.9 %
59 C
PACKS/NAI
N1 %
EGT
11.5
451
C
93.8
N2 %
360
FF KG/H
(METRIC UNITS)
800
FF LBS/H
(US UNITS OPTION)
A B
IGN
38
PSI
ENGINE
OIL
VIB N1
N2
EIPM 1
BOARD A
LOGICS
R2
CHAN A FUNCTION
CHAN B FUNCTION
SSPC
115VAC AC BUS 2
115VAC EMER BUS
EEC 2
CHAN A
CHAN B
IGNITION EXCITER "A"
IGNITION EXCITER "B"
IGNITER PLUG "A"
IGNITER PLUG "B"
N1
N2
EGT
FF
LP FUEL PRESS
FROM FUEL PUMP
FMV SERVOVALVE
A/C HPSOV SOLENOID
OVERSPEED SOLENOID
FUEL METERING VALVE
FMU
PRESS AND S/O
FF XMTR
MANIFOLDS

IGNITION AND STARTING SYSTEM DESCRIPTION

LB408521 - L5CT0T0 - LM7EDI000000001

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ENGINE START / CRANK CONTROL DESCRIPTION (3)

Instructions and Precautions For Engine Ground Operation

WARNING: - YOU MUST MAKE SURE THAT ALL AREAS WHERE YOU OPERATE THE ENGINE ARE AS CLEAN AS POSSIBLE. ALL AREAS MUST BE VERY CLEAN TO PREVENT INJURY AND SERIOUS DAMAGE TO THE ENGINE AND AIRCRAFT.

- YOU MUST NOT GO NEAR AN ENGINE THAT IS IN OPERATION ABOVE MINIMUM IDLE. IF YOU DO, IT CAN CAUSE AN INJURY. WHEN AN ENGINE IS IN OPERATION AT MINIMUM IDLE, YOU CAN ONLY GO NEAR IT THROUGH THE ENTRY CORRIDORS.
- TO ABORT THE ENGINE START SEQUENCE, YOU MUST PUT THE ENG/MASTER LEVER BACK TO THE OFF POSITION. IF YOU ONLY CHANGE THE POSITION OF THE ENGINE MODE ROTARY SELECTOR SWITCH (FROM IGN/START TO NORM), THE FADEC SYSTEM WILL NOT ABORT THE START SEQUENCE. THIS CAUSES A RISK THAT THE ENGINE WILL CONTINUE TO START. THIS, IN TURN, CAN CAUSE INJURIES TO PERSONNEL.
- BEFORE YOU OPERATE THE ENGINES AT POWER SETTINGS ABOVE IDLE, MAKE SURE THAT THERE IS NO RISK OF PRE-PRESSURIZATION OR RESIDUAL PRESSURE IN THE AIRCRAFT AFTER SUBSEQUENT ENGINE SHUTDOWN. TO DO THIS, MAKE SURE THAT THE AIR CONDITIONING OUTFLOW VALVES ARE OPEN DURING THE ENTIRE TEST.

IF PERSONS TRY TO OPEN A DOOR WHEN THERE IS RESIDUAL PRESSURE IN THE AIRCRAFT:

-THE DOOR CAN OPEN WITH DANGEROUS SUDDEN FORCE,

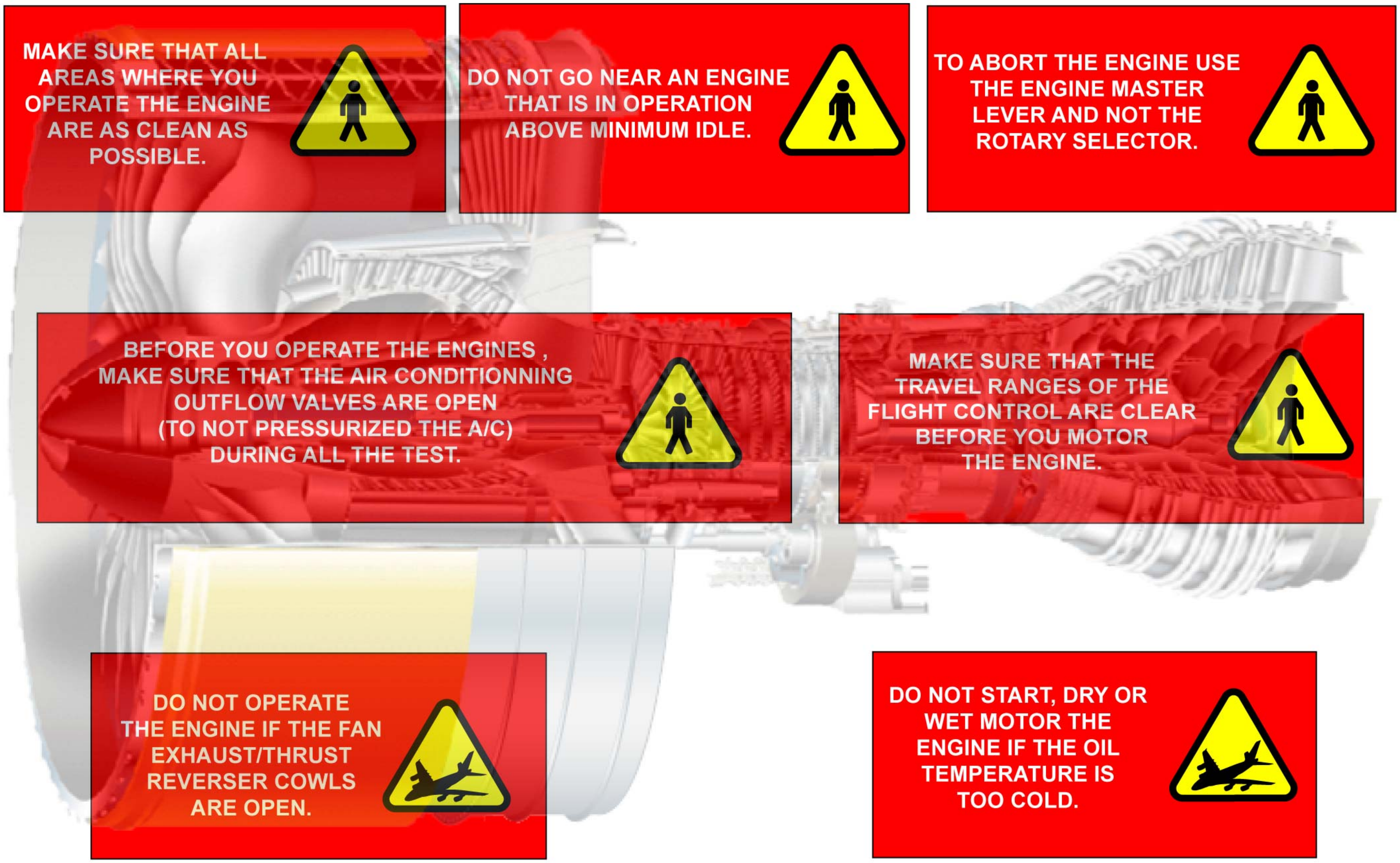
-THERE IS A RISK OF BAD INJURY OR DEATH, AND

-THERE CAN BE DAMAGE TO THE AIRCRAFT.

- MAKE SURE THAT THE TRAVEL RANGES OF THE FLIGHT CONTROL SURFACES ARE CLEAR BEFORE YOU MOTOR THE ENGINE. MOVEMENT OF THE FLIGHT CONTROL SURFACES CAN BE DANGEROUS AND/OR CAUSE DAMAGE.

CAUTION: - YOU MUST NO OPERATE THE ENGINE IF THE FAN EXHAUST/THRUST REVERSER COWLS ARE OPEN. IF THE ENGINE IS OPERATED WHEN THE FAN EXHAUST COWLS ARE OPEN, DAMAGE TO THE POWER PLANT CAN OCCUR.

- YOU MUST NOT START, DRY MOTOR OR WET MOTOR THE ENGINE IF THE OIL TEMPERATURE IS TOO COLD (REFER TO AMM). LOW OIL TEMPERATURES CAN CAUSE DAMAGE TO THE ENGINE BEARINGS.



MAKE SURE THAT ALL AREAS WHERE YOU OPERATE THE ENGINE ARE AS CLEAN AS POSSIBLE.

DO NOT GO NEAR AN ENGINE THAT IS IN OPERATION ABOVE MINIMUM IDLE.

TO ABORT THE ENGINE USE THE ENGINE MASTER LEVER AND NOT THE ROTARY SELECTOR.

BEFORE YOU OPERATE THE ENGINES , MAKE SURE THAT THE AIR CONDITIONNING OUTFLOW VALVES ARE OPEN (TO NOT PRESSURIZED THE A/C) DURING ALL THE TEST.

MAKE SURE THAT THE TRAVEL RANGES OF THE FLIGHT CONTROL ARE CLEAR BEFORE YOU MOTOR THE ENGINE.

DO NOT OPERATE THE ENGINE IF THE FAN EXHAUST/THRUST REVERSER COWLS ARE OPEN.

DO NOT START, DRY OR WET MOTOR THE ENGINE IF THE OIL TEMPERATURE IS TOO COLD.

INSTRUCTIONS AND PRECAUTIONS FOR ENGINE GROUND OPERATION

ENGINE START / CRANK CONTROL DESCRIPTION (3)

Automatic Start

The automatic start sequence can be automatically or manually aborted.

Automatic Start on Ground

The procedure to start the engine in automatic mode:
Initial configuration of controls (engine not running) is:
The ENG MASTER lever is set to the "OFF" position and the ENG START rotary selector is set to the "NORM" position.
Set the ENG START rotary selector to the "IGN/START" position. The ECAM ENGINE page is displayed and the Air Generation Unit (AGU) flow control valves close.
Set the ENG MASTER LEVER to the "ON" position. The Low Pressure (LP) fuel valve opens and the SAV opens.
When N2 reaches 20% the following events occur:
- The ignition is in function on the igniter A or B,
- The PRESS & S/O valve opens,
- The FF increases,
- The EGT increases.

When N2 reaches 55.7%,, the ignition cuts off.
When N2 reaches 58.4%, the SAV closes and the AGU flow control valves reopen if there is no other engine in starting sequence.

NOTE: The maximum of EGT during a start is 745°C.
Set the ENG START rotary selector to the "NORM" position. The ECAM ENGINE page disappears.

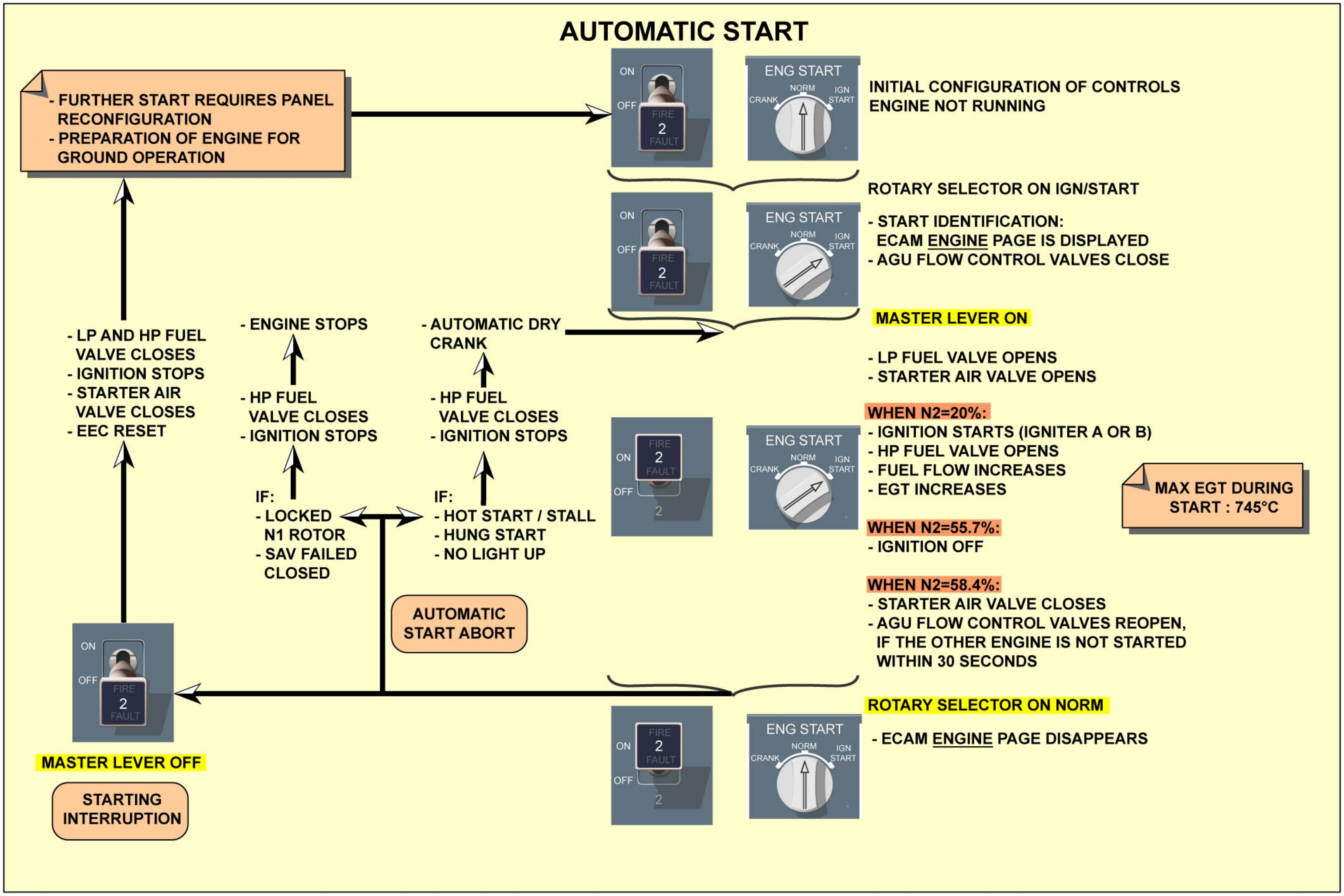
Automatic Start Abort

Automatic start abort is initiated when the following troubles occur:
- Hot start / stall
- Hung start,
- No light up,
- Locked N1 rotor,
- SAV failed closed.

If there is a fault, the PRESS & S/O valve automatically closes and the ignition stops.
If a hung start occurs, no new start is tried
If a hot start or no light up occurs, two new attempts are possible.
If there is an N1 rotor locked or a SAV failed closed, the engine start is automatically aborted.

Automatic Start Manual Abort

If a fault occurs you can at anytime SET the ENG MASTER lever to the "OFF" position.
ENG MASTER lever set to the "OFF" position has priority over the automatic mode. At this time the HP and LP fuel valves close, the ignition stops, the SAV closes and the EEC is reset.
To restart the engine, proceed to another automatic start.



AUTOMATIC START

INITIAL CONFIGURATION OF CONTROLS
ENGINE NOT RUNNING

ROTARY SELECTOR ON IGN/START

- START IDENTIFICATION:
  ECAM ENGINE PAGE IS DISPLAYED
- AGU FLOW CONTROL VALVES CLOSE

MASTER LEVER ON

- LP FUEL VALVE OPENS
- STARTER AIR VALVE OPENS

WHEN N2=20%:
- IGNITION STARTS (IGNITER A OR B)
- HP FUEL VALVE OPENS
- FUEL FLOW INCREASES
- EGT INCREASES

MAX EGT DURING START : 745°C

WHEN N2=55.7%:
- IGNITION OFF

WHEN N2=58.4%:
- STARTER AIR VALVE CLOSES
- AGU FLOW CONTROL VALVES REOPEN, IF THE OTHER ENGINE IS NOT STARTED WITHIN 30 SECONDS

ROTARY SELECTOR ON NORM

- ECAM ENGINE PAGE DISAPPEARS

AUTOMATIC START ABORT

IF:
- LOCKED N1 ROTOR
- SAV FAILED CLOSED

- HP FUEL VALVE CLOSES
- IGNITION STOPS

- ENGINE STOPS

IF:
- HOT START / STALL
- HUNG START
- NO LIGHT UP

- HP FUEL VALVE CLOSES
- IGNITION STOPS

- AUTOMATIC DRY CRANK

MASTER LEVER OFF

STARTING INTERRUPTION

- LP AND HP FUEL VALVE CLOSES
- IGNITION STOPS
- STARTER AIR VALVE CLOSES
- EEC RESET

- FURTHER START REQUIRES PANEL RECONFIGURATION
- PREPARATION OF ENGINE FOR GROUND OPERATION

AUTOMATIC START - AUTOMATIC START ON GROUND ... AUTOMATIC START MANUAL ABORT

ENGINE START / CRANK CONTROL DESCRIPTION (3)

Manual Start

The manual start sequence can only be aborted manually.

Manual Start on Ground

The procedure to start the engine in manual mode:
Initial configuration of controls (engine not running) is:
The ENG MASTER lever is set to the "OFF" position, the ENG START rotary selector is set to the "NORM" position and the ENG MAN START P/B SW "ON" legend lights off.
Set the ENG START rotary selector to the "IGN/START" position. The ECAM ENGINE page is displayed and the AGU flow control valve closes.
Set the ENG MAN START to the "ON" position. The SAV opens.
When N2 reaches 20%, set the ENG MASTER lever to the "ON" position. The following events occur:
- The ignition starts on the igniter A and B,
- The LP fuel valve and the PRESS & S/O valve open,
- The FF increases,

Start the chronometer:
- Within 30 seconds, the EGT increases.

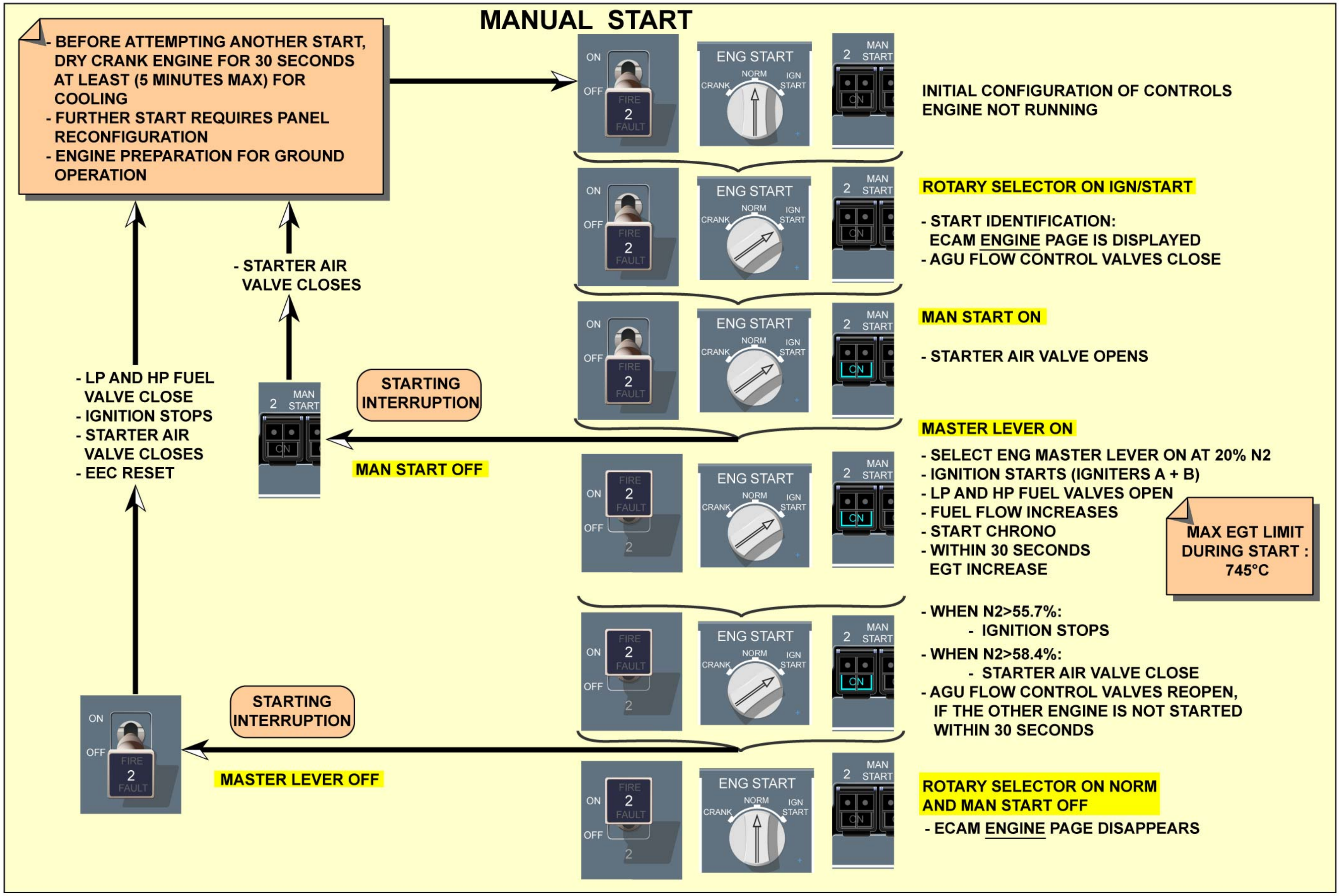
NOTE: The maximum EGT limit during a start is 745°C.
-When N2 reaches 55.7%, ignition stops,
-When N2 reaches 58.4%, SAV closes.
Set the ENG MAN START to the "OFF" position:
Set the ENG START rotary selector to the "NORM" position, the following actions occur:
- AGU flow control valves reopen if there is no other engine in starting sequence,
- The ECAM ENGINE page disappears.

Manual Start Interruption

Before setting the ENG MASTER lever to the "ON" position, you can interrupt the start sequence by setting the ENG MAN START P/B SW to the OFF position. This action causes the closing of SAV. If, a SAV failed closed or a locked N1 is detected you must set the ENG MAN START P/B SW to the "OFF" position.
After you set the ENG MASTER lever to the 'ON" position, you can interrupt the engine starting by setting the ENG MASTER lever to the "OFF" position. Following this action, the LP fuel valve and the PRESS & S/O valve close, the ignition stops, the SAV closes, and the EEC is reset.
The ENG MASTER lever must be set to the "OFF" position, if the following troubles occur:
- Hot start / stall
- Hung start,
- No light up,
- Locked N1 rotor,
- SAV failed closed.

Before attempting another start, dry crank the engine for 30 seconds at least (5 minutes max) for cooling.

MANUAL START



- BEFORE ATTEMPTING ANOTHER START, DRY CRANK ENGINE FOR 30 SECONDS AT LEAST (5 MINUTES MAX) FOR COOLING
- FURTHER START REQUIRES PANEL RECONFIGURATION
- ENGINE PREPARATION FOR GROUND OPERATION

INITIAL CONFIGURATION OF CONTROLS ENGINE NOT RUNNING

ROTARY SELECTOR ON IGN/START

- START IDENTIFICATION: ECAM ENGINE PAGE IS DISPLAYED
- AGU FLOW CONTROL VALVES CLOSE

MAN START ON

- STARTER AIR VALVE OPENS

MASTER LEVER ON

- SELECT ENG MASTER LEVER ON AT 20% N2
- IGNITION STARTS (IGNITERS A + B)
- LP AND HP FUEL VALVES OPEN
- FUEL FLOW INCREASES
- START CHRONO
- WITHIN 30 SECONDS EGT INCREASE

MAX EGT LIMIT DURING START : 745°C

- WHEN N2>55.7%:
  - IGNITION STOPS
- WHEN N2>58.4%:
  - STARTER AIR VALVE CLOSE
- AGU FLOW CONTROL VALVES REOPEN, IF THE OTHER ENGINE IS NOT STARTED WITHIN 30 SECONDS

ROTARY SELECTOR ON NORM AND MAN START OFF

- ECAM ENGINE PAGE DISAPPEARS

STARTING INTERRUPTION

MAN START OFF

- STARTER AIR VALVE CLOSES

STARTING INTERRUPTION

MASTER LEVER OFF

- LP AND HP FUEL VALVE CLOSE
- IGNITION STOPS
- STARTER AIR VALVE CLOSES
- EEC RESET

MANUAL START - MANUAL START ON GROUND & MANUAL START INTERRUPTION

ENGINE START / CRANK CONTROL DESCRIPTION (3)

Cranking

Dry crank or wet crank can be done.

Dry Crank

Dry crank is used to remove any residual fuel from the combustion chamber and to check if there is any oil leak.
During Initial configuration of controls (engine not running):
The ENG MASTER lever is set to the "OFF" position, the ENG START rotary selector is set to the "NORM" position and the ENG MAN START P/B SW "ON" legend lights are off.
Set the ENG START rotary selector to the "CRANK" position. The ECAM ENGINE page is displayed.
Set the ENG MAN START to the "ON" position. The SAV opens.
Start the chronometer.

NOTE: Dry crank the engine from 30 seconds up to 5 minutes maximum.

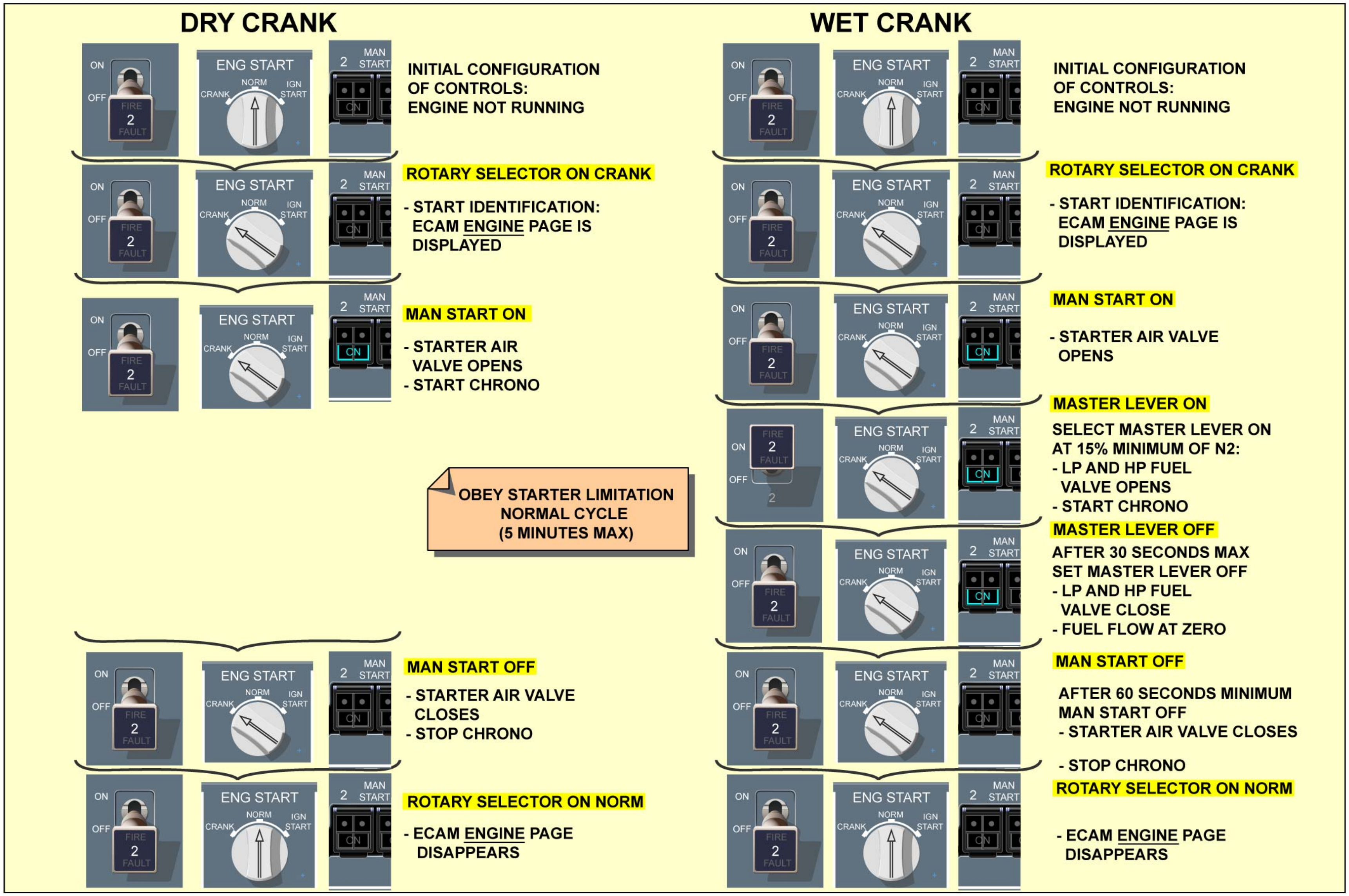
Set the ENG MAN START to the "OFF" position, SAV closes,
Stop the chronometer.
Set the ENG START rotary selector to the "NORM" position, the ECAM ENGINE page disappears.

Wet Crank

Wet crank is used to check if there are fuel leaks.
The Initial configuration of controls (engine not running) is:
The ENG MASTER LEVER set to the "OFF" position, the ENG START rotary selector set to the "NORM" position and the ENG MAN START P/B SW "ON" legend lights are off.

NOTE: Obey the starter limitation (normal cycle: 5 minutes maximum)

Set the ENG START rotary selector to the "CRANK" position, the ECAM ENGINE page is displayed.
Set the ENG MAN START to the "ON" position, the SAV opens.
When N2 reaches 15%, set the ENG MASTER lever to the "ON" position, LP fuel valve and the HP SOV open, start the chronometer.
After 30 seconds set the ENG MASTER lever to the "OFF" position, and the following events occur:
-LP and the HP fuel valves close (Make sure that the FF is at zero).
After 60 seconds set the ENG MAN START to the "OFF" position, the SAV closes.
Stop the chronometer.
Set the ENG START rotary selector to the "NORM" position, the ECAM ENGINE page disappears.



DRY CRANK

INITIAL CONFIGURATION OF CONTROLS: ENGINE NOT RUNNING

ROTARY SELECTOR ON CRANK

- START IDENTIFICATION: ECAM ENGINE PAGE IS DISPLAYED

MAN START ON

- STARTER AIR VALVE OPENS
- START CHRONO

OBEY STARTER LIMITATION NORMAL CYCLE (5 MINUTES MAX)

MAN START OFF

- STARTER AIR VALVE CLOSES
- STOP CHRONO

ROTARY SELECTOR ON NORM

- ECAM ENGINE PAGE DISAPPEARS

WET CRANK

INITIAL CONFIGURATION OF CONTROLS: ENGINE NOT RUNNING

ROTARY SELECTOR ON CRANK

- START IDENTIFICATION: ECAM ENGINE PAGE IS DISPLAYED

MAN START ON

- STARTER AIR VALVE OPENS

MASTER LEVER ON

SELECT MASTER LEVER ON AT 15% MINIMUM OF N2:
- LP AND HP FUEL VALVE OPENS
- START CHRONO

MASTER LEVER OFF

AFTER 30 SECONDS MAX SET MASTER LEVER OFF
- LP AND HP FUEL VALVE CLOSE
- FUEL FLOW AT ZERO

MAN START OFF

AFTER 60 SECONDS MINIMUM MAN START OFF
- STARTER AIR VALVE CLOSES
- STOP CHRONO

ROTARY SELECTOR ON NORM

- ECAM ENGINE PAGE DISAPPEARS

CRANKING - DRY CRANK & WET CRANK

ENGINE START OPS/CTL & IND (2)

General

This is a general view of the A380 cockpit.

GENERAL

LB408521 - L5CT0T0 - LM7EOULEVEL0201

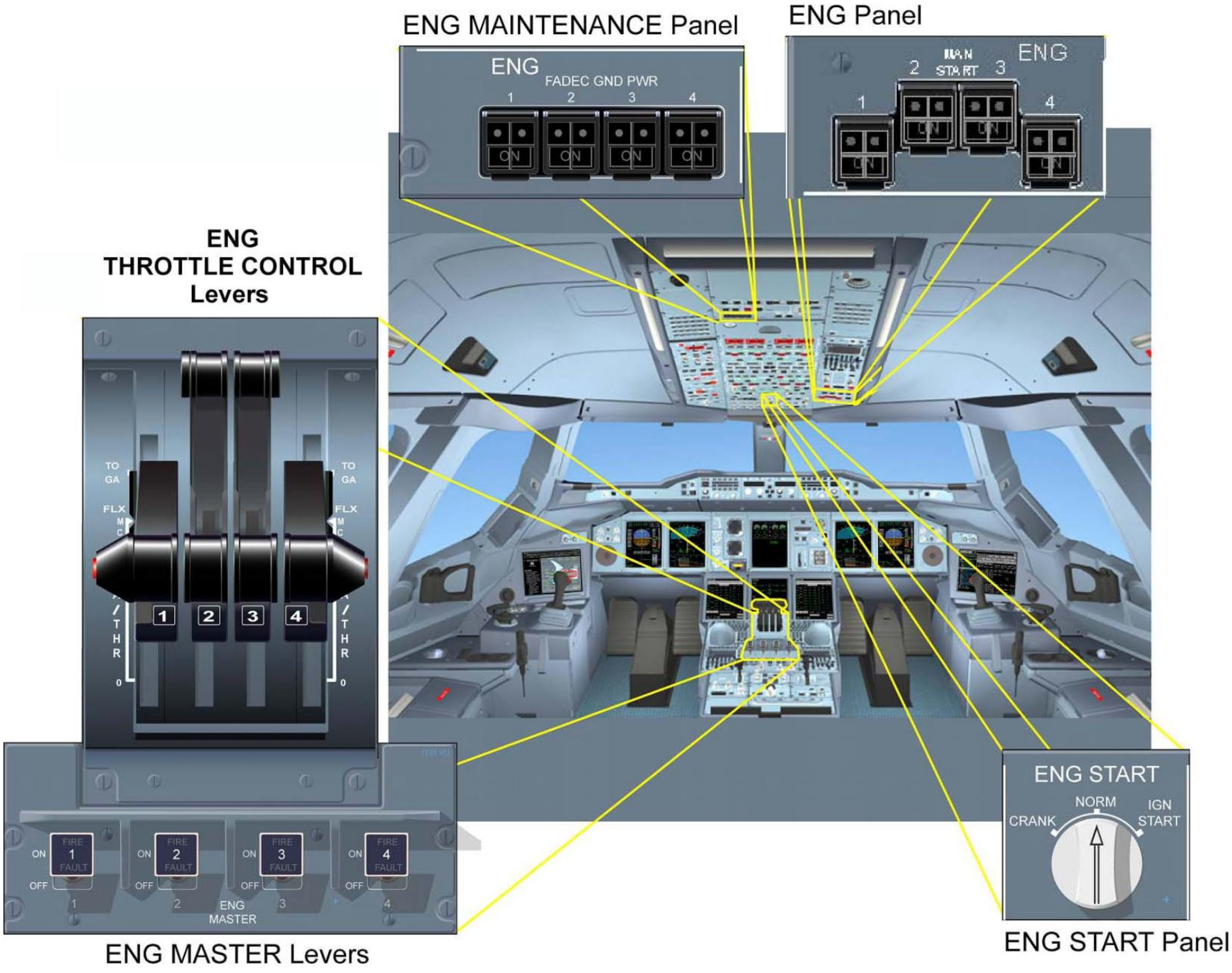
ENGINE START OPS/CTL & IND (2)

General (continued)

Engine Start Controls & Panels Location

On the overhead panel, the engine controls are:
- ENGine FADEC GrouND PoWeR panel,
- ENGine START mode selector,
- ENGine MANual START panel,

On the center pedestal, the engine start controls are:
- ENGine MASTER levers,
- ENGine Throttle Control Levers.


ENG MAINTENANCE Panel
ENG
FADEC GND PWR
1 2 3 4
ON ON ON ON
ENG Panel
ENG
MAN START
2 3
1 4
ON ON ON ON
ENG THROTTLE CONTROL Levers
TO GA
FLX MC
A/THR
0
1 2 3 4
ENG START
CRANK
NORM
IGN START
ENG START Panel
ON
OFF
FIRE 1 FAULT
FIRE 2 FAULT
FIRE 3 FAULT
FIRE 4 FAULT
1 2 3 4
ENG MASTER
ENG MASTER Levers

GENERAL - ENGINE START CONTROLS & PANELS LOCATION

ENGINE START OPS/CTL & IND (2)

Before Engine Start Preparation

Before you start the engine, you need:
- To ckeck the control safety test,
- To power the A/C,
-To start the APU and to deal with the bleed.
Perform an engine fire test and check that:
- The ENG FIRE pushbuttons lights come on,
- The SQUIB and DISCH lights come on,
- The FIRE lights come on, on the MASTER switches,
- The MASTER WARNING comes on,
- The Continuous Repetitive Chime (CRC) sounds,
- The ENGine FIRE warnings on ECAM E/WD,
- The ECAM ENG page appears,
Check the cockpit configuration:
- The ENG 1 MASTER LEVER is OFF,
- The ENG 2 MASTER LEVER is OFF,
- The ENG 3 MASTER LEVER is OFF,
- The ENG 4 MASTER LEVER is OFF,
- The ENG START selector switch is on NORMAL position,
- The ENG 1 MAN START is NORMAL,
- The ENG 2 MAN START is NORMAL,
- The ENG 3 MAN START is NORMAL,
- The ENG 4 MAN START is NORMAL,
- The ENG 1 FIRE is NORMAL,
- The ENG 2 FIRE is NORMAL,
- The ENG 3 FIRE is NORMAL,
- The ENG 4 FIRE is NORMAL,
- The ENG 1 THROTTLE CONTROL LEVER is on FWD IDLE position,
- The ENG 2 THROTTLE CONTROL LEVER is on FWD IDLE position,
- The ENG 3 THROTTLE CONTROL LEVER is on FWD IDLE position,
- The ENG 4 THROTTLE CONTROL LEVER is on FWD IDLE position,
- The ENG 2 THRUST REVERSER LEVER is on STOW POSITION,
- The ENG 3 THRUST REVERSER LEVER is on STOW POSITION,
- ECAM-E/WD & SD are powered,
- The FUEL PUMPS are ON,
- The FLAPS LEVER POSITION is at 0 position,
- The PARKING BRAKE is ON,
Inform the GROUND CREW before you start the engine.

Engine Start

After the preliminary cockpit preparation has been done, the engine start can be initiated.

Normal Start Procedure

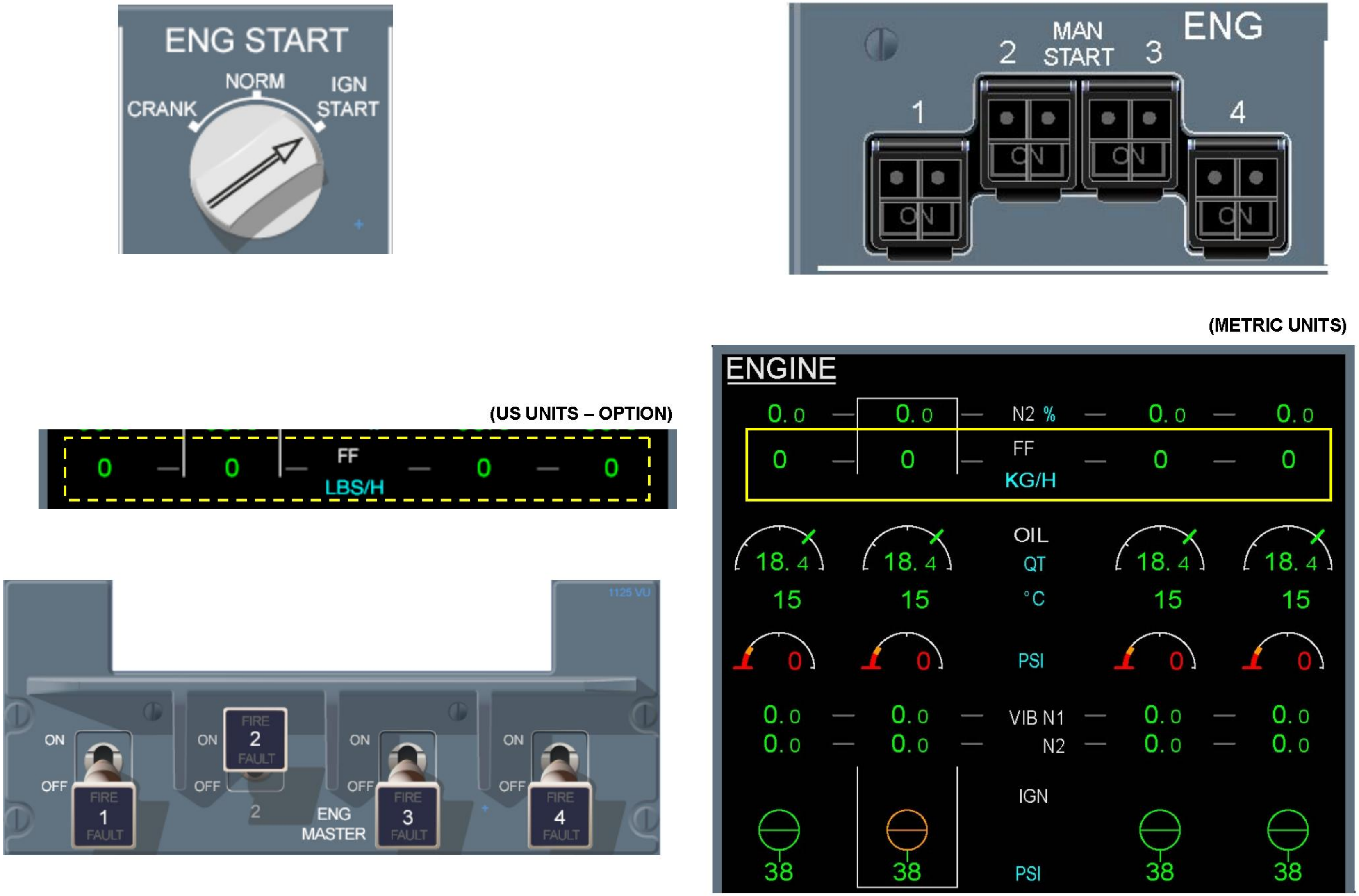
In normal start procedure, you start the engine in automatic mode.
The procedure to start the engine in automatic mode is to:
- Set the ENG START selector to the "IGN/START" position. The ECAM ENGINE page is displayed.
- Check all indications are normal and all parameters for logical indication,
- Ask the ground clearance to start the engine,
- When you obtain this clearance, announce the engine start,
- On the ECAM, check that the air pressure is above 25 psi,
- Set the ENG MASTER lever to the "ON" position,
- On ECAM, check that:
- The start valve is in line,
- The air pressure is above 25 psi,
- The N2 increases,
- The active igniter (A or B) is indicated,
- The fuel flow increases.
- Start the chrono
- The Oil pressure is green
- Within 30 seconds the EGT must increase and be monitored.
- When N2 reaches 55.7%, the igniters indication disappears.
- When N2 reaches 58.4%, the start valve is in cross line.

- When engine is at idle, check parameters for logical indication.

Engine Start Valve Fault

If a start valve fault is detected during engine start in automatic mode:
- A single chime sounds,
- The MASTER CAUTion lights come on,
- The ENG 2 START VALVE FAULT message is displayed on E/WD,
- The ENG START VALVE FAILED CLOSED caution is displayed on ECAM ENGINE page.

With the failure of the engine start in automatic mode, you can perform the engine start in manual mode with ground mechanic assistance.


ENG START
CRANK
NORM
IGN START
MAN START
ENG
1
2
3
4
ON
(US UNITS – OPTION)
FF
LBS/H
0
0
0
0
(METRIC UNITS)
ENGINE
0.0
N2 %
FF
KG/H
OIL
QT
18.4
15
°C
PSI
0
VIB N1
N2
IGN
PSI
38
ON
OFF
FIRE
1
2
3
4
FAULT
ENG MASTER
1125 VU

BEFORE ENGINE START PREPARATION & ENGINE START

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ENGINE START OPS/CTL & IND (2)

Engine Start with Assistance

In case of the engine start failure in automatic mode, you will have to perform a specific procedure to start the engine in manual mode with ground mechanic assistance:

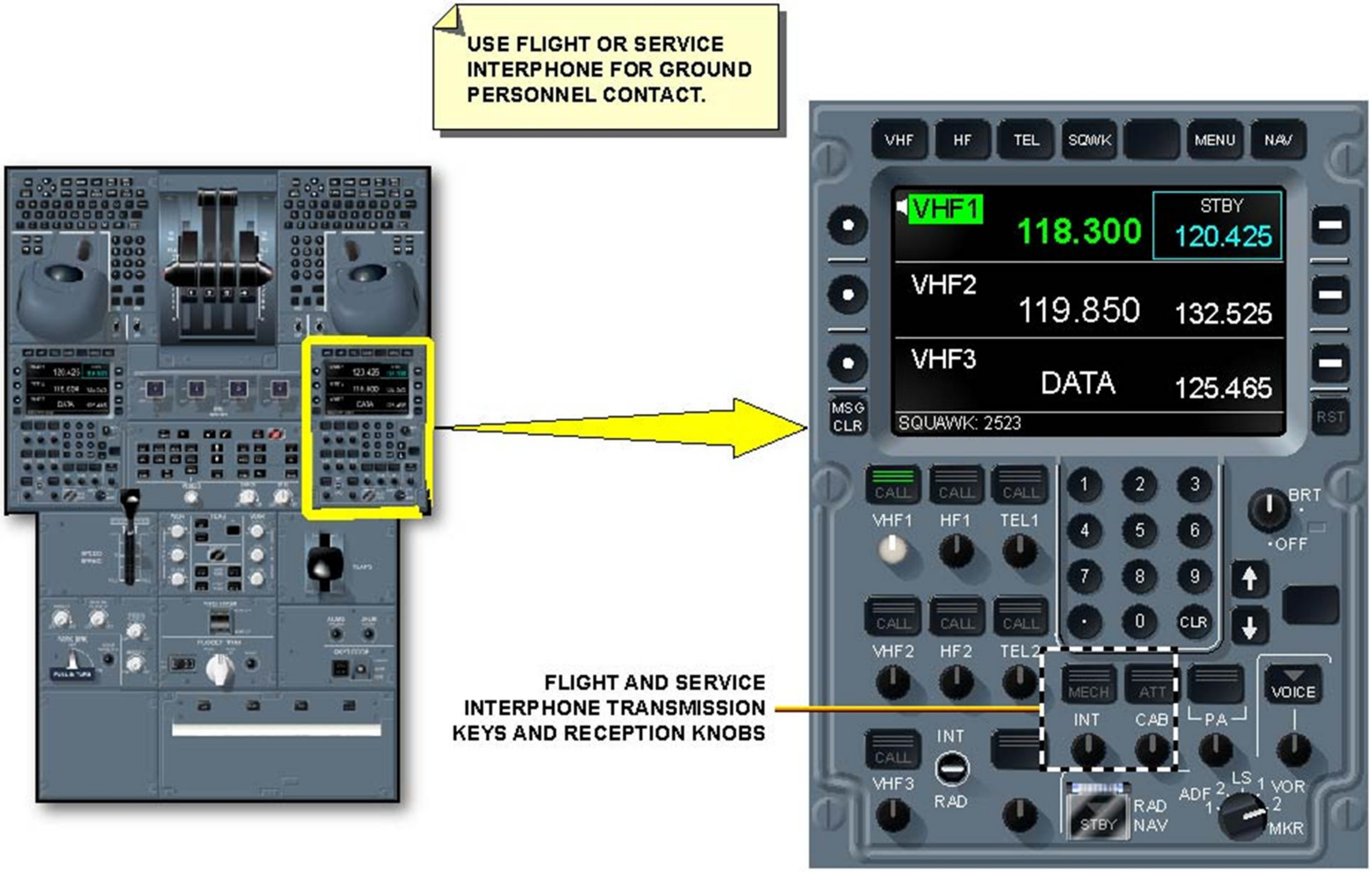
Start Procedure

Before you start the engine, check the cockpit configuration:
- The ENG 1 MASTER LEVER is OFF,
- The ENG 2 MASTER LEVER is OFF,
- The ENG 3 MASTER LEVER is OFF,
- The ENG 4 MASTER LEVER is OFF,
- The ENG START selector switch is on NORMAL position,
- The ENG 1 MAN START is NORMAL,
- The ENG 2 MAN START is NORMAL,
- The ENG 3 MAN START is NORMAL,
- The ENG 4 MAN START is NORMAL,
- The ENG 1 FIRE is NORMAL,
- The ENG 2 FIRE is NORMAL,
- The ENG 3 FIRE is NORMAL,
- The ENG 4 FIRE is NORMAL,
- The ENG 1 THROTTLE CONTROL LEVER is on FWD IDLE position,
- The ENG 2 THROTTLE CONTROL LEVER is on FWD IDLE position,
- The ENG 3 THROTTLE CONTROL LEVER is on FWD IDLE position,
- The ENG 4 THROTTLE CONTROL LEVER is on FWD IDLE position,
- The ENG 2 THRUST REVERSER LEVER is on STOW POSITION,
- The ENG 3 THRUST REVERSER LEVER is on STOW POSITION,
- ECAM-E/WD & SD are powered,
- The FUEL PUMPS are ON,
- The FLAPS LEVER POSITION is at 0 position,
- The PARKING BRAKE is ON,

Inform the GROUND CREW before you start the engine.

Radio Management Panel

Use flight or service interphone to establish the contact with the ground personnel. The Radio Management Panels (RMPs) located on the center pedestal give the controls to manage this communication. With the CALLS/MECH P/BSW on the overhead panel you can make a call to the ground mechanic and you can validate a call from the ground mechanic by pressing the MECH P/BSW on the RMP (cf ATA23).


USE FLIGHT OR SERVICE INTERPHONE FOR GROUND PERSONNEL CONTACT.
FLIGHT AND SERVICE INTERPHONE TRANSMISSION KEYS AND RECEPTION KNOBS
VHF
HF
TEL
SQWK
MENU
NAV
VHF1
118.300
STBY
120.425
VHF2
119.850
132.525
VHF3
DATA
125.465
SQUAWK: 2523
MSG CLR
RST
CALL
VHF1
HF1
TEL1
VHF2
HF2
TEL2
VHF3
1
2
3
4
5
6
7
8
9
.
0
CLR
BRT
OFF
MECH
ATT
INT
CAB
PA
VOICE
INT
RAD
STBY
RAD NAV
ADF
LS
VOR
MKR

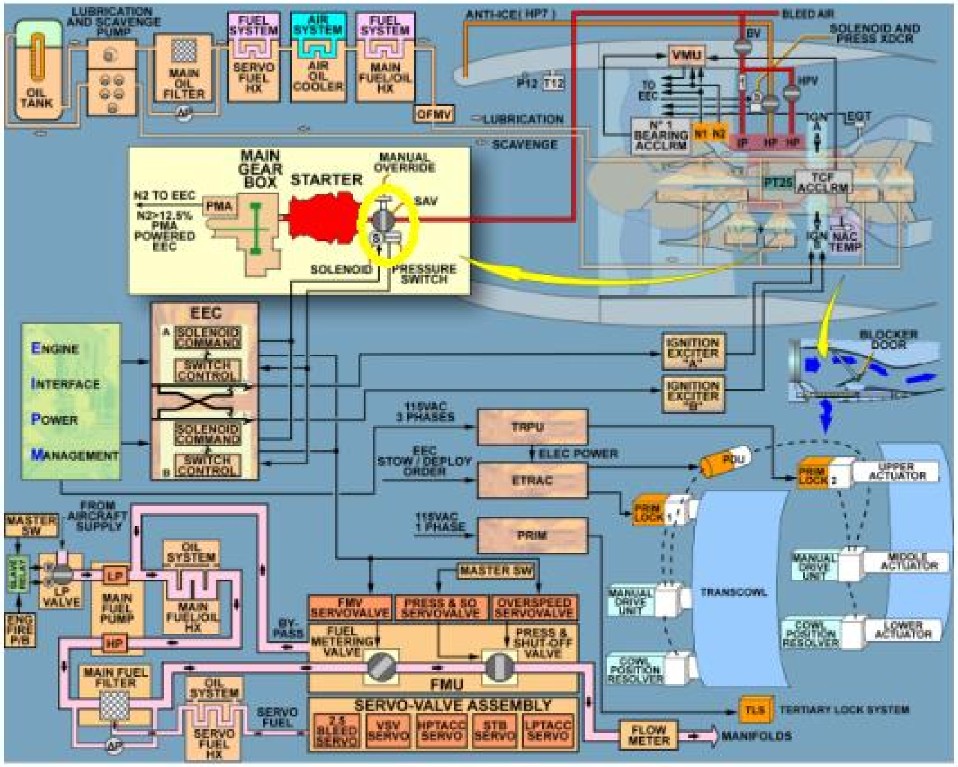
ENGINE START WITH ASSISTANCE - START PROCEDURE & RADIO MANAGEMENT PANEL

ENGINE START OPS/CTL & IND (2)

Engine Start with Assistance (continued)

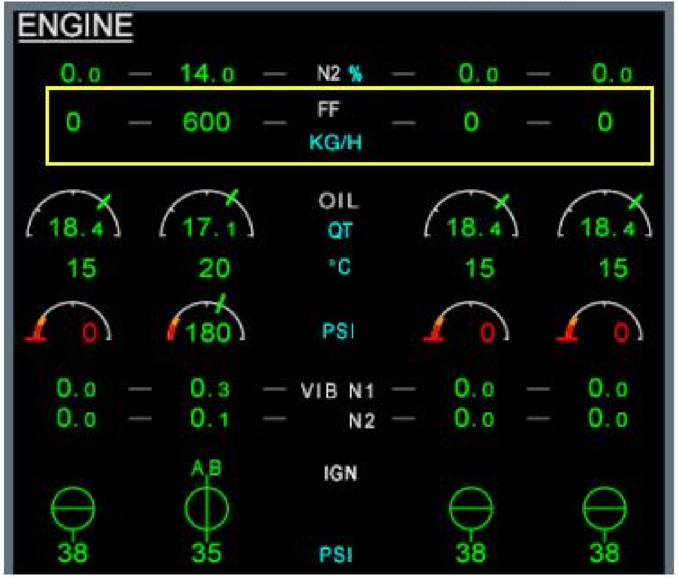
Engine Manual Start

The procedure to start the engine in manual mode is to:
- Set the ENG START selector to the "IGN/START" position. The ECAM ENGINE page is displayed.
- Check if all indications are normal and all parameters for logical indications,
- Ask the ground clearance to start the engine,
- If the GROUND CLEARANCE is obtained, announce the engine 2 start,
- Check the air pressure is above 25 psi on the ECAM ENGINE page,
- Set the ENG MAN START 2 to the "ON" position.
- Contact the ground crew to turn the start valve in OPEN position.
- On the ECAM, check that the start valve is in line and the start valve air pressure is upper 25 psi. The N2 and the oil pressure increase,
- When N2 reaches 20%, set the ENG MASTER lever to the "ON" position. On ECAM ENGINE page the active igniter (A or B) and the fuel flow are indicated and the oil pressure is green.
- Start the chronometer and within 30 seconds, the EGT increases and must be monitored.
- At N2 above 55%, contact the ground mechanic crew to close the start valve. On ECAM, the start valve is in cross line and the igniter indication disappears.
- Set the ENG MAN START to the "OFF" position,
- When the engine is at idle, check parameters for logical indication.


LUBRICATION AND SCAVENGE PUMP
OIL TANK
MAIN OIL FILTER
FUEL SYSTEM
AIR SYSTEM
FUEL SYSTEM
SERVO FUEL HX
AIR OIL COOLER
MAIN FUEL/OIL HX
OFMV
LUBRICATION
SCAVENGE
ANTI-ICE (HP7)
BLEED AIR
SOLENOID AND PRESS XDCR
VMU
BV
HPV
TO EEC
N° 1 BEARING ACCLRM
N1 N2
IP HP HP
IGN
EGT
PT25
TCF ACCLRM
NAC TEMP
MAIN GEAR BOX
STARTER
MANUAL OVERRIDE
SAV
N2 TO EEC
N2>12.5% PMA POWERED EEC
PMA
SOLENOID
PRESSURE SWITCH
EEC
SOLENOID COMMAND
SWITCH CONTROL
SOLENOID COMMAND
SWITCH CONTROL
ENGINE INTERFACE POWER MANAGEMENT
IGNITION EXCITER "A"
IGNITION EXCITER "B"
BLOCKER DOOR
115VAC 3 PHASES
TRPU
ELEC POWER
EEC STOW / DEPLOY ORDER
ETRAC
115VAC 1 PHASE
PRIM
PDU
PRIM LOCK
UPPER ACTUATOR
TRANSCOWL
MANUAL DRIVE UNIT
MIDDLE ACTUATOR
COWL POSITION RESOLVER
LOWER ACTUATOR
TLS
TERTIARY LOCK SYSTEM
MASTER SW
FROM AIRCRAFT SUPPLY
LP VALVE
LP
OIL SYSTEM
MAIN FUEL PUMP
MAIN FUEL/OIL HX
HP
ENG FIRE P/B
BY-PASS
MAIN FUEL FILTER
OIL SYSTEM
SERVO FUEL HX
SERVO FUEL
FMV SERVOVALVE
PRESS & SO SERVOVALVE
OVERSPEED SERVOVALVE
FUEL METERING VALVE
PRESS & SHUT-OFF VALVE
FMU
SERVO-VALVE ASSEMBLY
2.5 BLEED SERVO
VSV SERVO
HPTACC SERVO
STB SERVO
LPTACC SERVO
FLOW METER
MANIFOLDS

COCKPIT CREW ORDERS TO MECHANIC, FOR OPENING OF THE STARTER CONTROL VALVE

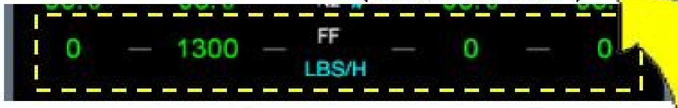
(METRIC UNITS)



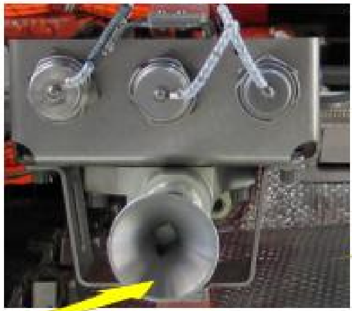
ENGINE

0.0	14.0	N2 %	0.0	0.0
0	600	FF KG/H	0	0
18.4	17.1	OIL QT	18.4	18.4
15	20	°C	15	15
0	180	PSI	0	0
0.0	0.3	VIB N1	0.0	0.0
0.0	0.1	N2	0.0	0.0
	A B	IGN		
38	35	PSI	38	38

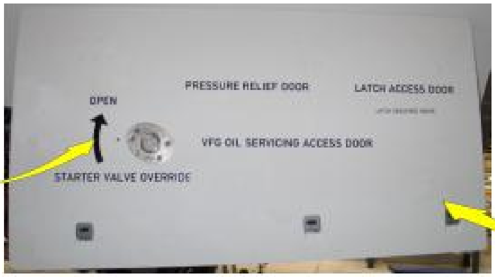
(US UNITS – OPTION)



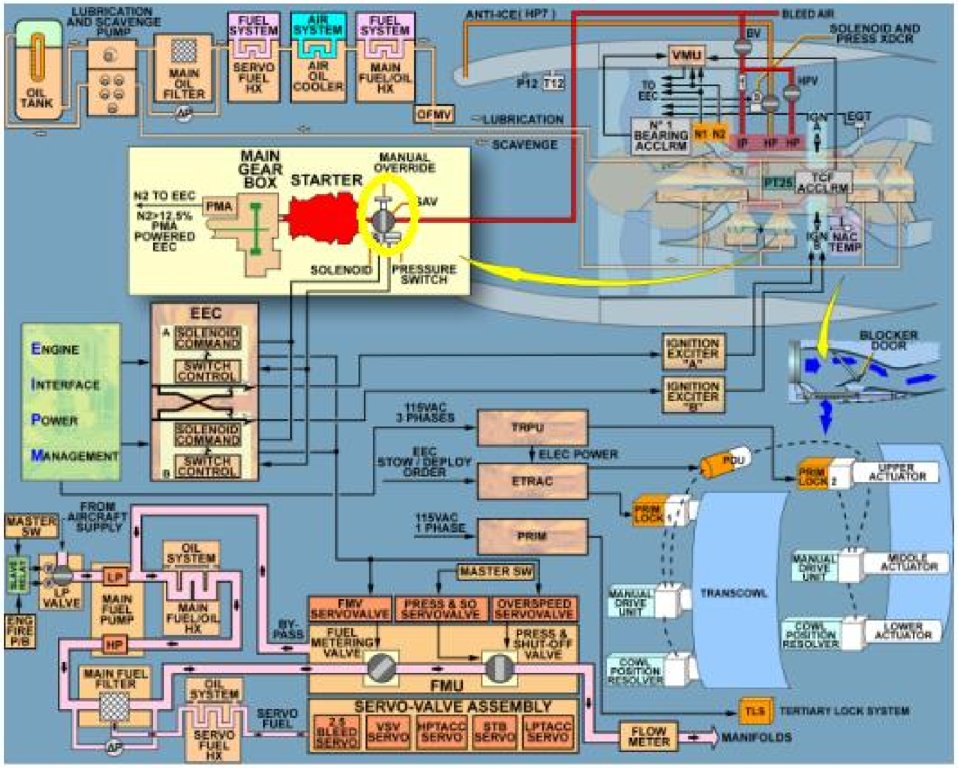
0	1300	FF LBS/H	0	0



FLEXIBLE SHAFT

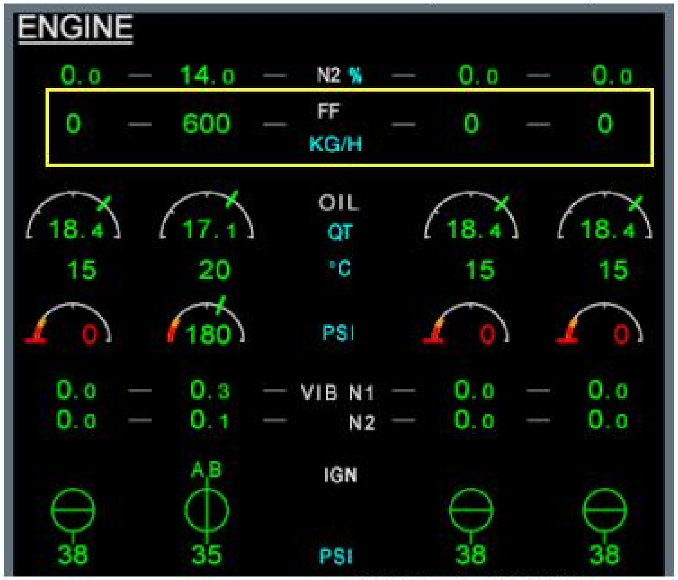

OPEN
PRESSURE RELIEF DOOR
LATCH ACCESS DOOR
VFG OIL SERVICING ACCESS DOOR
STARTER VALVE OVERRIDE

ENGINE START WITH ASSISTANCE - ENGINE MANUAL START


LUBRICATION AND SCAVENGE PUMP
OIL TANK
MAIN OIL FILTER
ΔP
FUEL SYSTEM
SERVO FUEL HX
AIR SYSTEM
AIR OIL COOLER
FUEL SYSTEM
MAIN FUEL/OIL HX
OFMV
LUBRICATION
SCAVENGE
ANTI-ICE(HP7)
BLEED AIR
SOLENOID AND PRESS XDCR
VMU
BV
HPV
P12 T12
TO EEC
N° 1 BEARING ACCLRM
N1 N2
IP HP HP
IGN
EGT
PT25
TCF ACCLRM
IGN
NAC TEMP
MAIN GEAR BOX
STARTER
MANUAL OVERRIDE
SAV
N2 TO EEC
N2>12.5% PMA POWERED EEC
PMA
SOLENOID
PRESSURE SWITCH
EEC
A
SOLENOID COMMAND
SWITCH CONTROL
SOLENOID COMMAND
SWITCH CONTROL
B
ENGINE INTERFACE POWER MANAGEMENT
IGNITION EXCITER "A"
IGNITION EXCITER "B"
BLOCKER DOOR
115VAC 3 PHASES
TRPU
ELEC POWER
EEC STOW / DEPLOY ORDER
ETRAC
115VAC 1 PHASE
PRIM
PDU
PRIM LOCK
PRIM LOCK
UPPER ACTUATOR
MANUAL DRIVE UNIT
TRANSCOWL
MANUAL DRIVE UNIT
MIDDLE ACTUATOR
COWL POSITION RESOLVER
COWL POSITION RESOLVER
LOWER ACTUATOR
TLS
TERTIARY LOCK SYSTEM
MASTER SW
FROM AIRCRAFT SUPPLY
SLAVE RELAY
LP VALVE
ENG FIRE P/B
LP
MAIN FUEL PUMP
HP
OIL SYSTEM
MAIN FUEL/OIL HX
BY-PASS
MASTER SW
FMV SERVOVALVE
PRESS & SO SERVOVALVE
OVERSPEED SERVOVALVE
FUEL METERING VALVE
PRESS & SHUT-OFF VALVE
FMU
SERVO-VALVE ASSEMBLY
2.5 BLEED SERVO
VSV SERVO
HPTACC SERVO
STB SERVO
LPTACC SERVO
MAIN FUEL FILTER
OIL SYSTEM
SERVO FUEL HX
SERVO FUEL
ΔP
FLOW METER
MANIFOLDS

COCKPIT CREW ORDERS TO MECHANIC, FOR CLOSURE OF THE STARTER CONTROL VALVE AT ENGINE N2 SPEED ABOVE 55%.

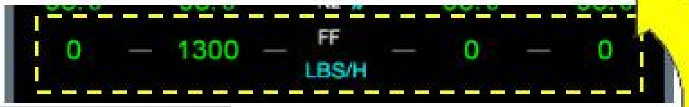
(METRIC UNITS)



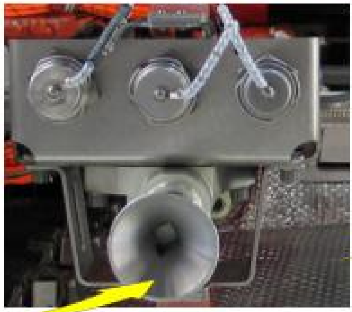
ENGINE

0.0	14.0	N2 %	0.0	0.0
0	600	FF KG/H	0	0
18.4	17.1	OIL QT	18.4	18.4
15	20	°C	15	15
0	180	PSI	0	0
0.0	0.3	VIB N1	0.0	0.0
0.0	0.1	N2	0.0	0.0
	AB	IGN		
38	35	PSI	38	38

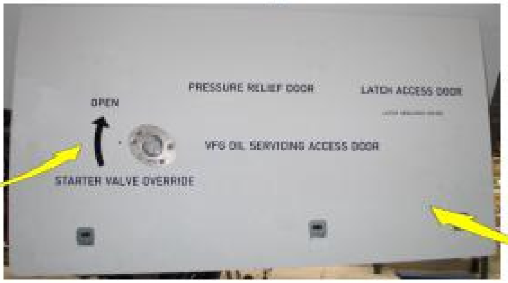
(US UNITS – OPTION)



0	1300	FF LBS/H	0	0



FLEXIBLE SHAFT


PRESSURE RELIEF DOOR
LATCH ACCESS DOOR
OPEN
VFG OIL SERVICING ACCESS DOOR
STARTER VALVE OVERRIDE

ENGINE START WITH ASSISTANCE - ENGINE MANUAL START

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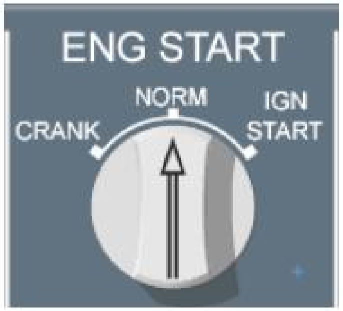
ENGINE START OPS/CTL & IND (2)

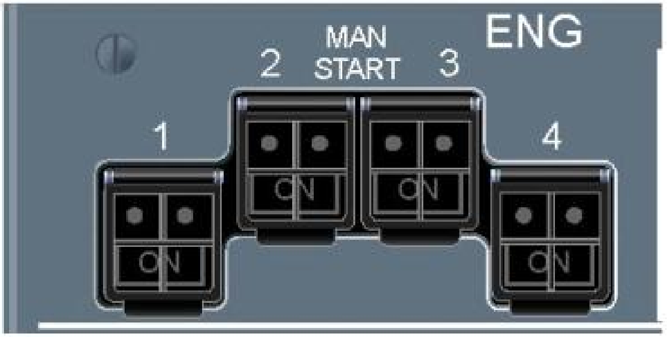
After Engine Start

To finalize the starting sequence, an engine start procedure, the system must be set in its normal configuration:
- The ENG START SELECTOR switch is set to NORMal position, the ECAM wheel page appears,
- The ELEC GROUND POWER is removed if not anymore required,
- The ENG ANTI ICE P/B is set to OFF if the engine anti-ice is not required.

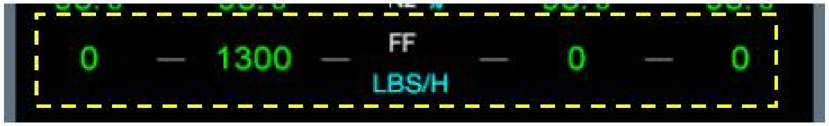
NOTE: Icing conditions may be expected if the OAT is below 8°C with visible moisture (fog).

- the ENG BLEED P/B is set ON,
- The CROSS BLEED VALVE selector is set in AUTO position,
- APU BLEED P/B is set OFF,
- PACK 1 & 2 P/Bs are ON,
- Check the PARKING BRAKE pressure,
- Select the ENGINE page.


ENG START
CRANK
NORM
IGN START

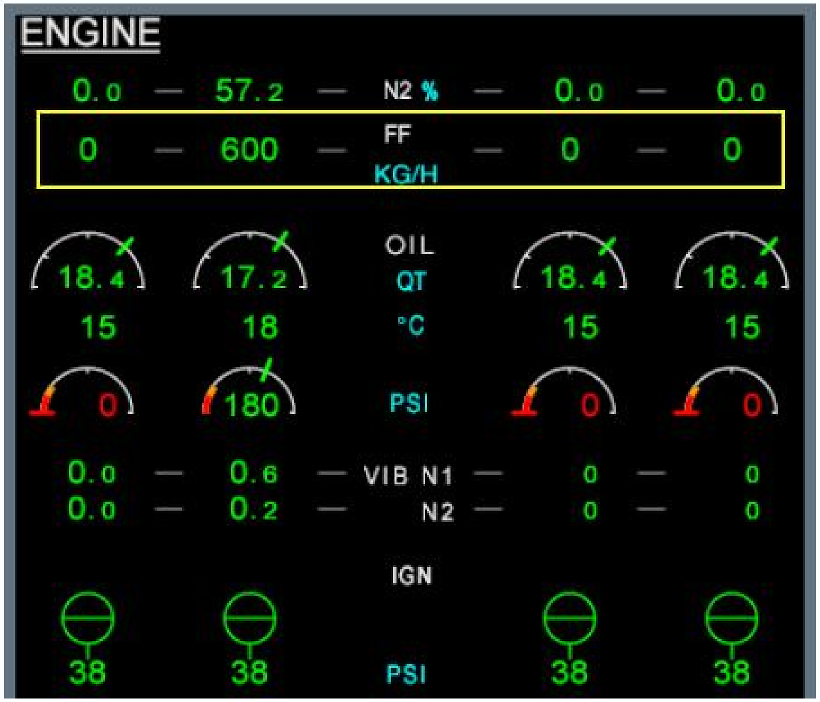

MAN START
ENG
1
2
3
4
ON
ON
ON
ON

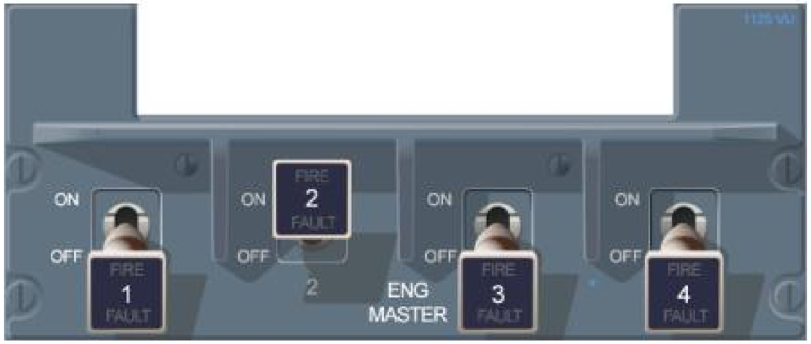
(US UNITS – OPTION)


0
1300
FF
LBS/H
0
0

ENGINE START COMPLETED

(METRIC UNITS)


ENGINE
0.0
57.2
N2 %
0.0
0.0
0
600
FF
KG/H
0
0
18.4
17.2
OIL
QT
18.4
18.4
15
18
°C
15
15
0
180
PSI
0
0
0.0
0.6
VIB N1
0
0
0.0
0.2
N2
0
0
IGN
38
38
PSI
38
38

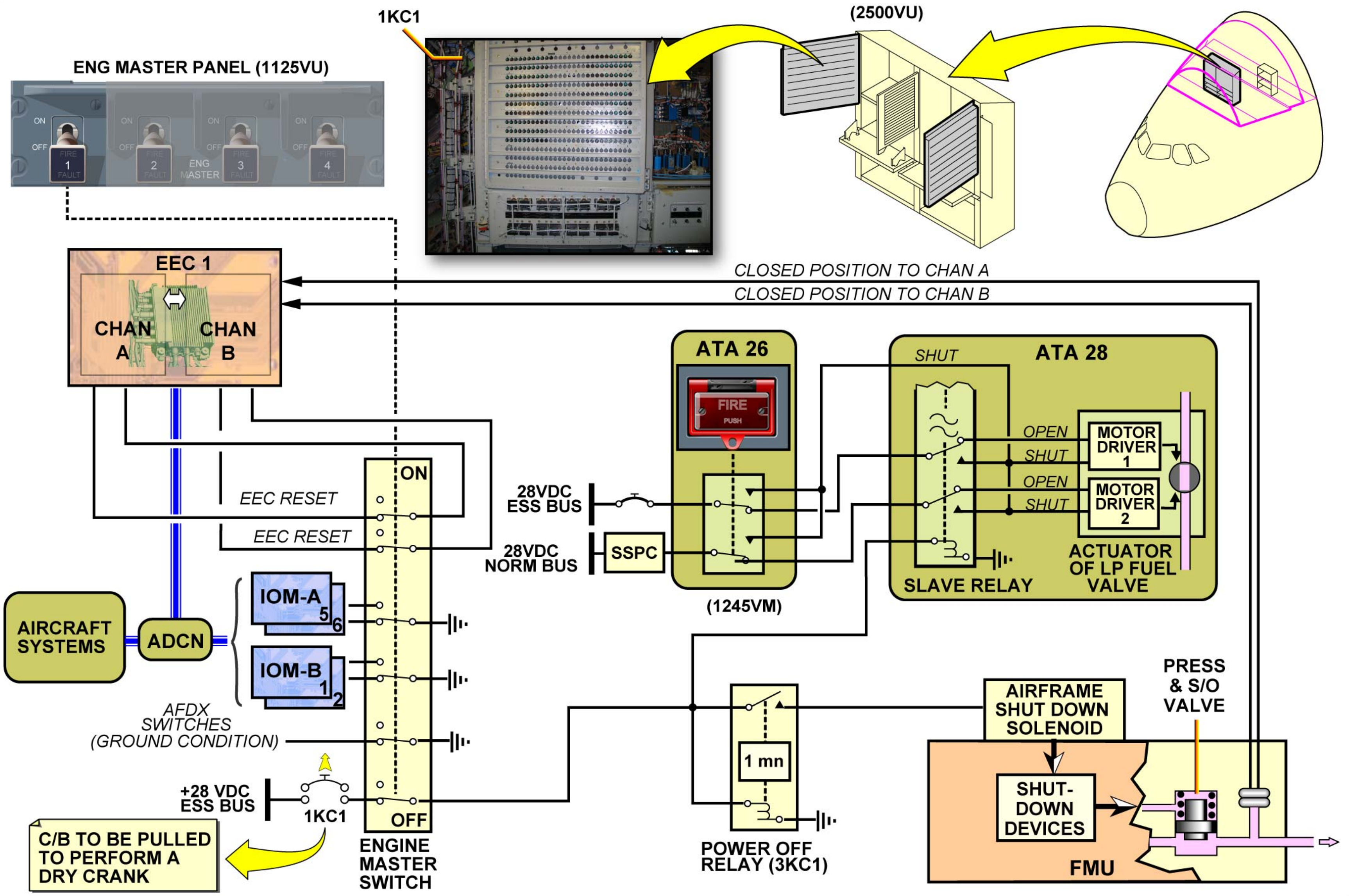

ON
OFF
FIRE
1
FAULT
ON
OFF
FIRE
2
FAULT
ENG MASTER
ON
OFF
FIRE
3
FAULT
ON
OFF
FIRE
4
FAULT

AFTER ENGINE START

ENGINE MAINTENANCE (3)

LP Shut-Off and PRESSure & Shut-Off Valves Commands and Power Supply

The ENGine MASTER lever controls:
-The reset of the Electronic Engine Control (EEC) A and B channels,
-The excitation of the ENG MASTER SW SLAVE relay, which controls the LP fuel valve actuator,
-The excitation of the airframe shut down solenoid, which controls the HP fuel valve actuator.
When the ENG MASTER lever is set to the "OFF" position, the 28 VDC ESSentiel bus supplies the slave relay.
The slave relay switches the power supply from 28 VDC ESS BUS and 28 VDC NORMal bus to the "SHUT" position of the motor driver of the LP fuel valve.
With ENG MASTER lever on the "OFF" position, pulling the breaker 1KC1, if the ENG FIRE P/B is not released, can open the LP fuel valve.
To operate a dry crank the ENG MASTER lever must be set to the "OFF" position. When a dry crank is initiated, the fuel must lubricate the fuel pump assembly, so the breaker 1KC1 must be pulled.
The breaker 1KC1 is located on the emergency power center (2500VU) in the emergency avionics compartment


1KC1
(2500VU)
ENG MASTER PANEL (1125VU)
ON
OFF
FIRE
1
FAULT
2
ENG MASTER
3
4
EEC 1
CHAN A
CHAN B
CLOSED POSITION TO CHAN A
CLOSED POSITION TO CHAN B
ATA 26
FIRE
PUSH
SHUT
ATA 28
OPEN
SHUT
OPEN
SHUT
MOTOR DRIVER 1
MOTOR DRIVER 2
ON
EEC RESET
EEC RESET
28VDC ESS BUS
28VDC NORM BUS
SSPC
SLAVE RELAY
ACTUATOR OF LP FUEL VALVE
(1245VM)
AIRCRAFT SYSTEMS
ADCN
IOM-A
5
6
IOM-B
1
2
AFDX SWITCHES (GROUND CONDITION)
PRESS & S/O VALVE
AIRFRAME SHUT DOWN SOLENOID
1 mn
SHUT-DOWN DEVICES
FMU
+28 VDC ESS BUS
1KC1
OFF
C/B TO BE PULLED TO PERFORM A DRY CRANK
ENGINE MASTER SWITCH
POWER OFF RELAY (3KC1)

LP SHUT-OFF AND PRESSURE & SHUT-OFF VALVES COMMANDS AND POWER SUPPLY

LB408521 - L5CT0T0 - LM7EY3000000001

ENGINE MAINTENANCE (3)

General Preservation of the Engine for the Storage

Prepare the engine for storage to protect against damage from excessive moisture, debris, and other environmental conditions.
There are 3 methods of preservation::
- Method I - Preservation of the engine for 30 days (Ref .AMM TASK 71-00-00-620-804)
- Method II - Preservation of the engine for 90 days or less (Ref AMM TASK 71-00-00-620-802)
- Method III - Preservation of the engine for 365 days or less (Ref. AMM TASK 71-00-00-620-805)

If the duration of the storage is not sure, use the method III
If the engine was split and the propulsor stored, method III is recommended.

WARNING: REFER TO THE MSDS (MATERIAL SAFETY DATA SHEET) FOR ALL MATERIAL USED AND TO THE MANUFACTURER'S SAFETY INSTRUCTIONS FOR ALL EQUIPMENT USED.
INJURY CAN OCCUR IF YOU DO NOT OBEY THIS WARNING

CAUTION: BE CAREFUL IN LOCATIONS WHERE LARGE TEMPERATURE CHANGES, HUMIDITY, OR SALT WATER CAN CAUSE A HIGHER RISK OF DAMAGE TO ENGINE PARTS

REFER TO THE MSDS (MATERIAL SAFETY DATA SHEET) FOR ALL MATERIAL USED AND TO THE MANUFACTURER'S SAFETY INSTRUCTIONS FOR ALL EQUIPMENT USED.
INJURY CAN OCCUR IF YOU DO NOT OBEY THIS WARNING

BE CAREFUL IN LOCATIONS WHERE LARGE TEMPERATURE CHANGES, HUMIDITY, OR SALT WATER CAN CAUSE A HIGHER RISK OF DAMAGE TO ENGINE PARTS.

GENERAL PRESERVATION OF THE ENGINE FOR THE STORAGE

LB408521 - L5CT0T0 - LM7EY3000000001

ENGINE MASTER CONTROL DESCRIPTION (3)

General

The ENGine MASTER lever located on the center pedestal interfaces with the fuel system and the FADEC system.
In the fuel system, the ENG MASTER lever acts on the LP valve and the Pressure and Shut Off Valve (PRESS & S/O Valve)
The engine FIRE pushbutton also acts on the LP fuel valve.
On the FADEC system, the ENG MASTER lever is used for the starting mode selection and the Electronic Engine Control (EEC) memory reset functions.

Low Pressure fuel valve and Airframe Shut Down Solenoid

The ENGine MASTER lever is directly hardwired to the airframe shut down solenoid of the Fuel Metering Unit (FMU). It also controls the Low Pressure fuel valve through the engine MASTER switch relay.
Setting the lever from the "ON" to the "OFF" position directly energizes the airframe shut down solenoid then, the PRESS & S/O valve moves to the close position.
After one minute, the power off relay de-energizes the solenoid in order to avoid heat dissipation into the FMU.
This gives independent authority to close the PRESS & S/O valve regardless of the EEC command.

ENGine MASTER and Network Interface

The ENGine MASTER lever is directly hardwired to each channel of the EEC. Each channel sends its own discrete signal via the EEC internal data bus to the other channel.
This signal is used to keep the ENG MASTER lever position readable into the EEC in case of AFDX failure.
The ENG MASTER lever is also hardwired to the IOM and interfaces with the EEC through the ADCN.

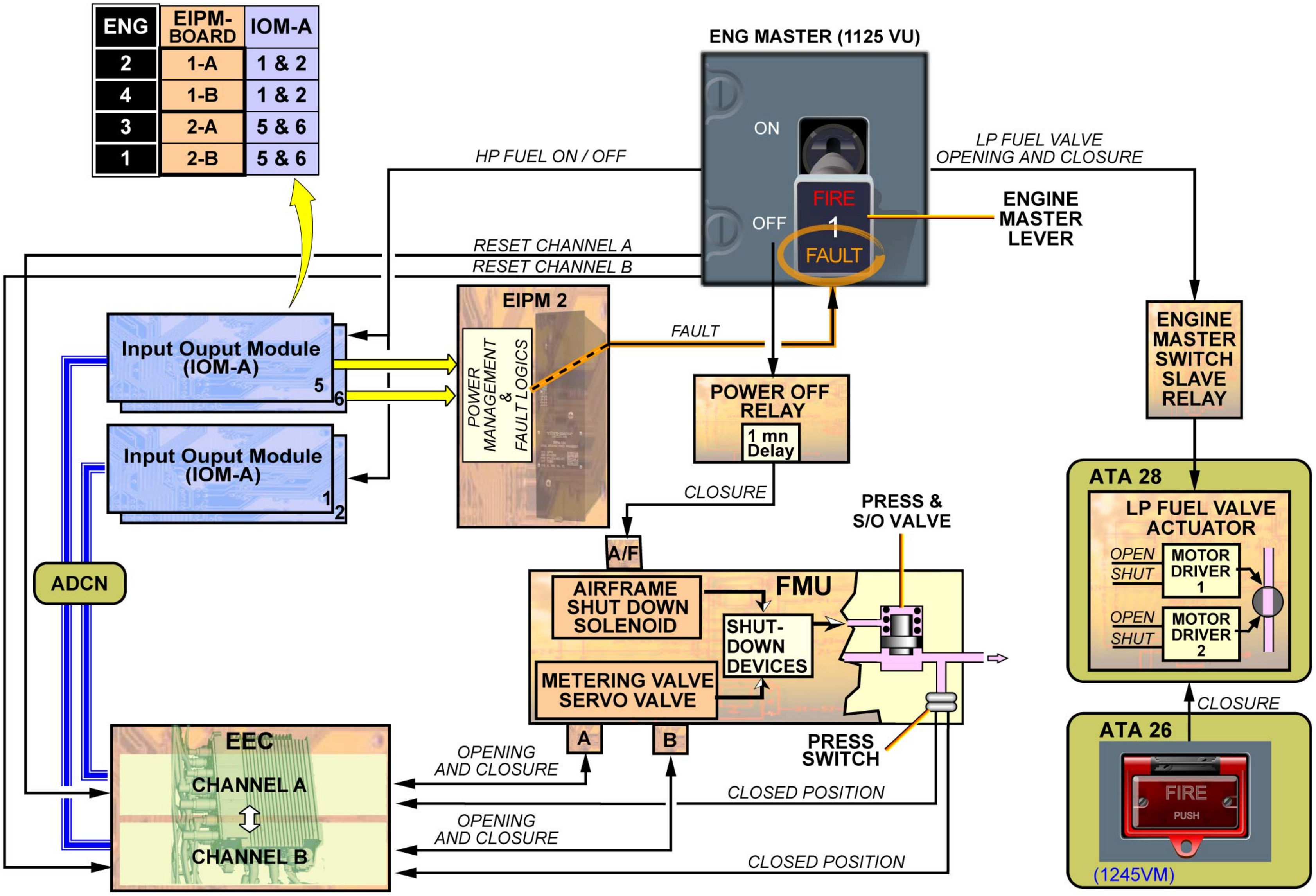
The ENG MASTER lever uses the ADCN signals as source to arbitrate in case of disagreement between network signals or discrete signals into the EEC.
The ENG MASTER lever signal acts on the metering valve servo valve of the FMU, which is the second device to turn on or off the PRESS & S/O Valve.

ENGine MASTER and EEC Reset

Moving the ENGine MASTER lever from "ON" to "OFF" position, closes both channel reset discrete contacts, resetting both EEC channels; all data stored in the EEC memory will be cleared.

ENGine MASTER FAULT Light

The amber "FAULT" light located on the ENGine MASTER lever indicates a disagreement between the PRESS & S/O Valve position and its commanded position.
This light also illuminates for any fault occurred during engine start.
The ENG MASTER lever FAULT light is managed by the EIPM, based on the digital data received from the related EEC via the IOM.



ENG	EIPM-BOARD	IOM-A
2	1-A	1 & 2
4	1-B	1 & 2
3	2-A	5 & 6
1	2-B	5 & 6

ENG MASTER (1125 VU)
ON
OFF
FIRE
1
FAULT
HP FUEL ON / OFF
LP FUEL VALVE OPENING AND CLOSURE
ENGINE MASTER LEVER
RESET CHANNEL A
RESET CHANNEL B
EIPM 2
POWER MANAGEMENT & FAULT LOGICS
FAULT
Input Ouput Module (IOM-A)
5
6
Input Ouput Module (IOM-A)
1
2
POWER OFF RELAY
1 mn Delay
ENGINE MASTER SWITCH SLAVE RELAY
CLOSURE
PRESS & S/O VALVE
ATA 28
LP FUEL VALVE ACTUATOR
OPEN
SHUT
MOTOR DRIVER 1
OPEN
SHUT
MOTOR DRIVER 2
ADCN
A/F
FMU
AIRFRAME SHUT DOWN SOLENOID
SHUT-DOWN DEVICES
METERING VALVE SERVO VALVE
A
B
PRESS SWITCH
CLOSURE
ATA 26
FIRE
PUSH
(1245VM)
EEC
CHANNEL A
CHANNEL B
OPENING AND CLOSURE
CLOSED POSITION
OPENING AND CLOSURE
CLOSED POSITION

GENERAL ... ENGINE MASTER FAULT LIGHT

THROTTLE CONTROL ASSEMBLY DESCRIPTION (3)

General

The Throttle Control Assembly (TCA) design is based on a modular concept.
It is composed of 4 independent assemblies (two inboard assemblies and two outboard assemblies), each one dedicated to one engine.
Each assembly is composed of:
- A housing,
- A throttle control lever,
- A thrust reverser lever (inboard assemblies, engines 2 and 3),
- An Auto THRust (A/THR) instinctive disconnect push button (outboard assemblies, engines 1 and 4),
- Electrical connectors.

Modulation of Engine Thrust

Except during A/THR mode, control of the forward thrust of each engine shall be achieved by modulation of the related throttle control lever position.
The throttle control levers can only be manually moved and the four throttle control levers can be moved independently.
The throttle control levers move over a sector divided into three areas separated by pre-determined detent points and stops.
The detent points and stops are used to select the thrust limit mode.

Thrust Reverser Mode

Control of the reverse thrust of either engine 2 or 3 is achieved by modulating the position of the thrust reverser levers fitted on the throttle control lever inboard assemblies.
Control of the stow/deploy sequence is achieved when the thrust reverser levers are in the reverser area.
As for the throttle control levers, the thrust reverser levers can be moved independently.
When the throttle control levers are not at idle, the thrust reverser levers are mechanically locked in the stowed position.

Sensing Devices

The primary function of the Throttle Control Assembly (TCA) is to sense the commands and to generate electric signals. This lever position information is received by several A/C systems.
The throttle control lever sensing devices are composed of 4 independent groups of 2 resolvers, and 4 independent groups of 3 potentiometers.
The deployed order from the thrust reverser lever (inboard levers only) is given by means of a switch (one per lever).
These 2 switch signals are obtained through one track of the potentiometers.

Throttle Control Levers and Thrust Reverser Levers Detents Points and Stops

The device including the detent points and stops gives tactile information to select a thrust limit mode with the throttle control lever and to select the thrust reverser operation with the thrust reverser levers.
The detents points and stops of the throttle control lever are located as follows:
- 0 (idle) - stop (0°)
- CL (maximum CLimb) - detent point (30.34°)
- FLX / MCT (FleXible takeoff / Maximum Continuous Thrust) - detent point (42.22°)
- TO GA (TakeOff / Go Around) - stop (54.55°)

The detent point and stops of thrust reverser lever are located as follows:
- 0: idle - stop (0°)
- IDLE REV (idle reverse) - detent point (50.84°)
- MAX REV (maximum reverse) - stop (96.07°)

Each assembly has its own detent point and stop device

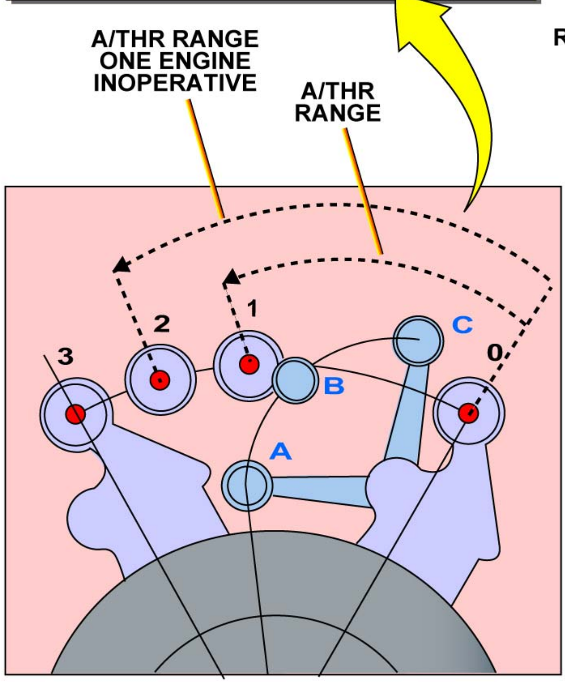
The normal operating range for A/THR is comprised between idle (0) stop to max CLimb (CL) detent points.
If one engine is inoperative the A/THR range is comprised between idle (0) stop to Max Continuous Thrust (MCT) detent points.

THROTTLE CONTROL LEVERS DETENTS POINTS AND STOPS

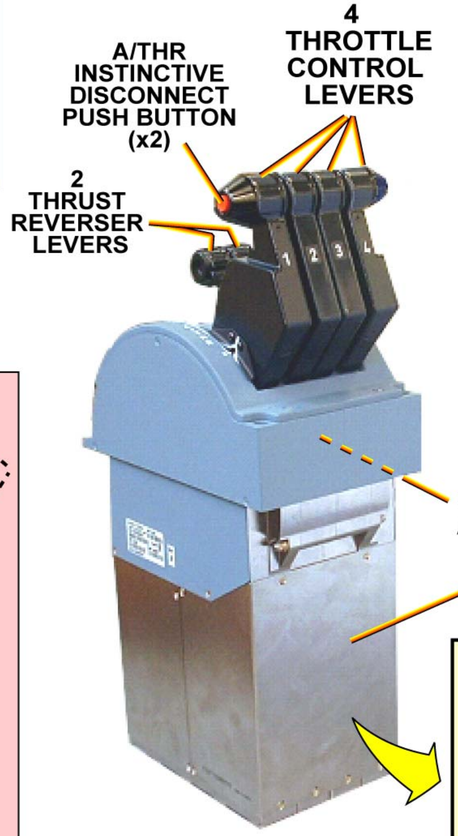
0	0 (IDLE) - STOP
1	CL (MAXIMUM CLIMB) - DETENT
2	FLX (FLEXIBLE TAKEOFF) - DETENT MCT (MAXIMUM CONTINUOUS THRUST)
3	TO (TAKEOFF) - STOP GA (GO AROUND)

THRUST REVERSER LEVERS DETENT POINT AND STOPS

A	0 (IDLE) - STOP
B	IDLE REV (IDLE REVERSE)- DETENT
C	MAX REV (MAXIMUM REVERSE) - STOP

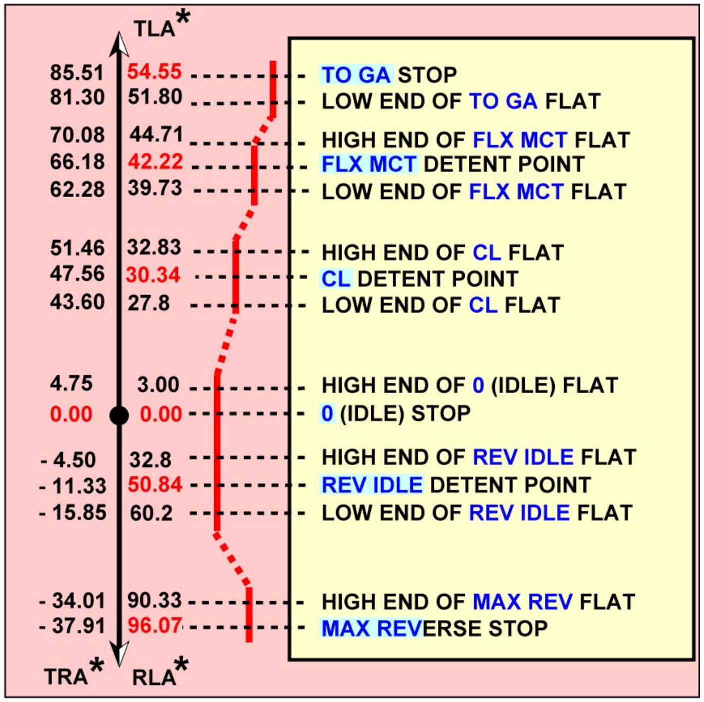


THROTTLE CONTROL ASSEMBLY (TCA)


A/THR INSTINCTIVE DISCONNECT PUSH BUTTON (x2)
4 THROTTLE CONTROL LEVERS
2 THRUST REVERSER LEVERS
1
2
3
4

FOUR FULLY INDEPENDENT ASSEMBLIES TIED TOGETHER

MECHANICAL MODULE AND SENSING DEVICES



TLA*

TRA*	RLA*	
85.51	54.55	TO GA STOP
81.30	51.80	LOW END OF TO GA FLAT
70.08	44.71	HIGH END OF FLX MCT FLAT
66.18	42.22	FLX MCT DETENT POINT
62.28	39.73	LOW END OF FLX MCT FLAT
51.46	32.83	HIGH END OF CL FLAT
47.56	30.34	CL DETENT POINT
43.60	27.8	LOW END OF CL FLAT
4.75	3.00	HIGH END OF 0 (IDLE) FLAT
0.00	0.00	0 (IDLE) STOP
- 4.50	32.8	HIGH END OF REV IDLE FLAT
- 11.33	50.84	REV IDLE DETENT POINT
- 15.85	60.2	LOW END OF REV IDLE FLAT
- 34.01	90.33	HIGH END OF MAX REV FLAT
- 37.91	96.07	MAX REVERSE STOP

SENSING DEVICES :

8 RESOLVERS
(2/ THROTTLE CONTROL LEVER)

12 POTENTIOMETERS
(3/ THROTTLE CONTROL LEVER)

2 SWITCHES THROUH
1 TRACK OF POTENTIOMETER
(1/ THRUST REVERSER LEVER)

* R EVERSER
L EVER
A NGLE

T HROTTLE
L EVER
A NGLE

T HROTTLE
R ESOLVER
A NGLE

GENERAL ... THROTTLE CONTROL LEVERS AND THRUST REVERSER LEVERS DETENTS POINTS AND STOPS

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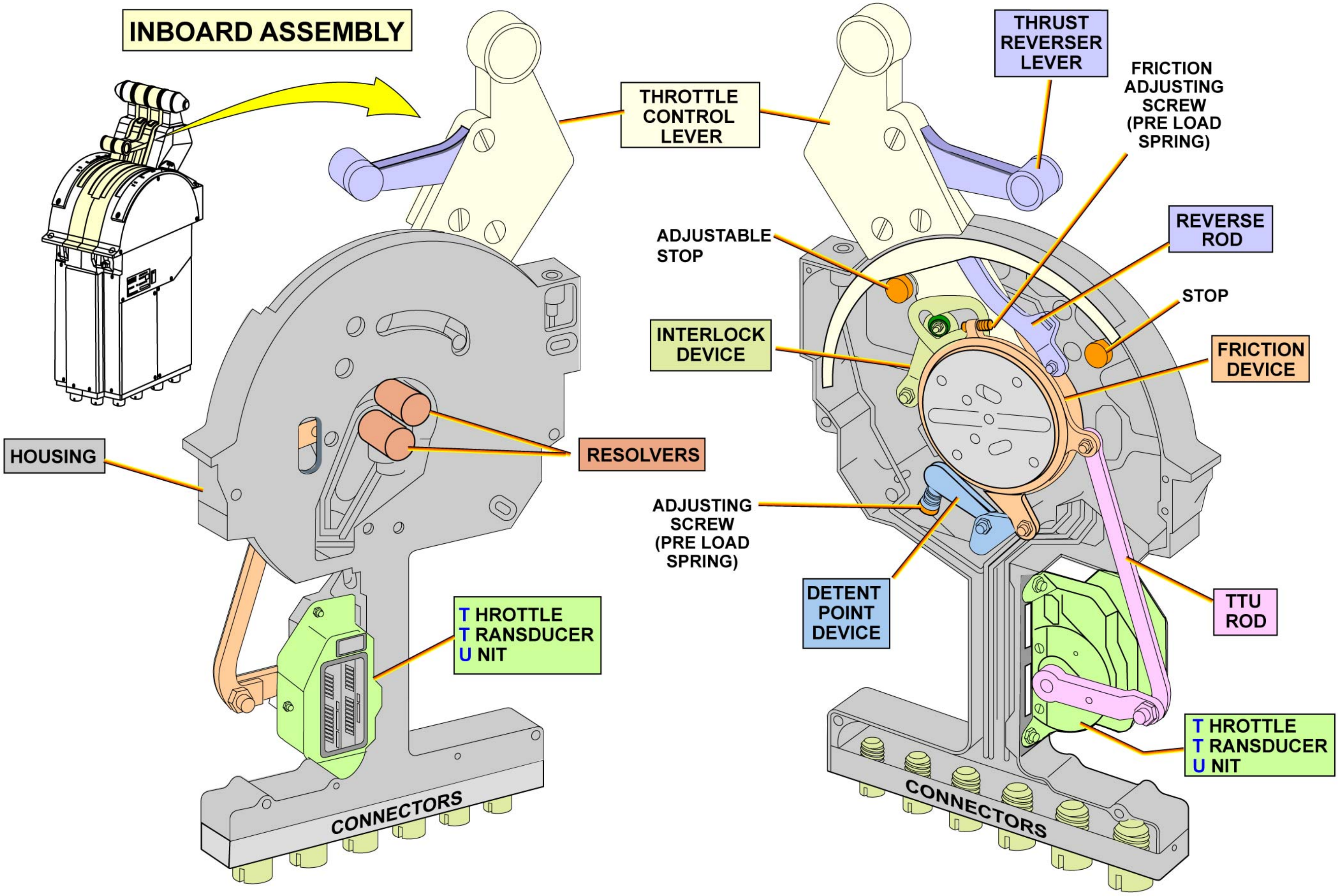
THROTTLE CONTROL ASSEMBLY DESCRIPTION (3)

Inboard and Outboard Assemblies

There are internal mechanical features in each inboard and outboard assembly, which are:
-The artificial force feel device (friction force),
-The soft detent point device, related to several thrust limit modes,
-The interlock device (inboard assemblies only).
There are internal electrical features into each inboard and outboard assembly, which are:
-The 3 potentiometers and one switch (inboard assemblies) which are installed inside the Throttle Transducer Unit (TTU),
-The 2 resolvers,
-A/THR instinctive disconnect pushbutton (outboard assemblies),
-The electrical connectors.

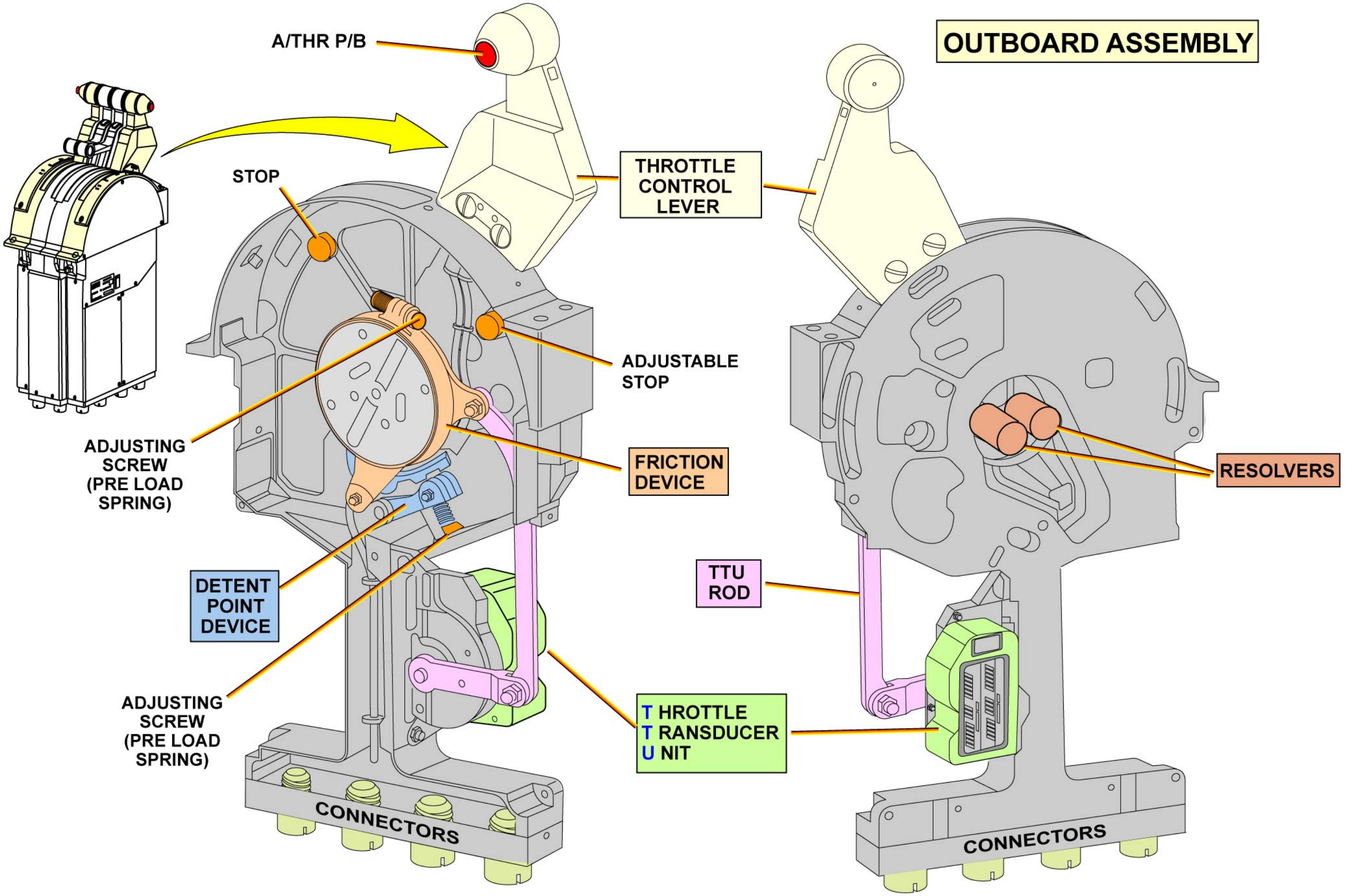
Interlock Device

This mechanism is implemented only on inboard assemblies.
The function of the interlock device is to prevent the movement of the thrust reverser levers from the stowed position if one of the throttle control levers is out of the forward idle position.
The interlock also has the following functionalities:
-To prevent the movement of the throttle control lever forward or backward from the idle position if the trust reverser lever is raised.
-Automatic recall of the throttle lever to idle when thrust reverser lever is moved.
-Automatic recall of the thrust reverser lever to neutral when the throttle control levers are moved from idle and when thrust reverser levers are positioned between 0° and 10°.


INBOARD ASSEMBLY
THROTTLE CONTROL LEVER
THRUST REVERSER LEVER
FRICTION ADJUSTING SCREW (PRE LOAD SPRING)
ADJUSTABLE STOP
REVERSE ROD
STOP
INTERLOCK DEVICE
FRICTION DEVICE
HOUSING
RESOLVERS
ADJUSTING SCREW (PRE LOAD SPRING)
DETENT POINT DEVICE
TTU ROD
THROTTLE TRANSDUCER UNIT
THROTTLE TRANSDUCER UNIT
CONNECTORS
CONNECTORS

INBOARD AND OUTBOARD ASSEMBLIES - INTERLOCK DEVICE

LB408521 - L5CT0T0 - LM7ED4000000001


A/THR P/B
OUTBOARD ASSEMBLY
STOP
THROTTLE CONTROL LEVER
ADJUSTABLE STOP
ADJUSTING SCREW (PRE LOAD SPRING)
FRICTION DEVICE
RESOLVERS
DETENT POINT DEVICE
TTU ROD
ADJUSTING SCREW (PRE LOAD SPRING)
THROTTLE TRANSDUCER UNIT
CONNECTORS
CONNECTORS

INBOARD AND OUTBOARD ASSEMBLIES - INTERLOCK DEVICE

LB408521 - L5CT0T0 - LM7ED4000000001

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THROTTLE CONTROL ASSEMBLY DESCRIPTION (3)

Throttle Control Assembly Interfaces

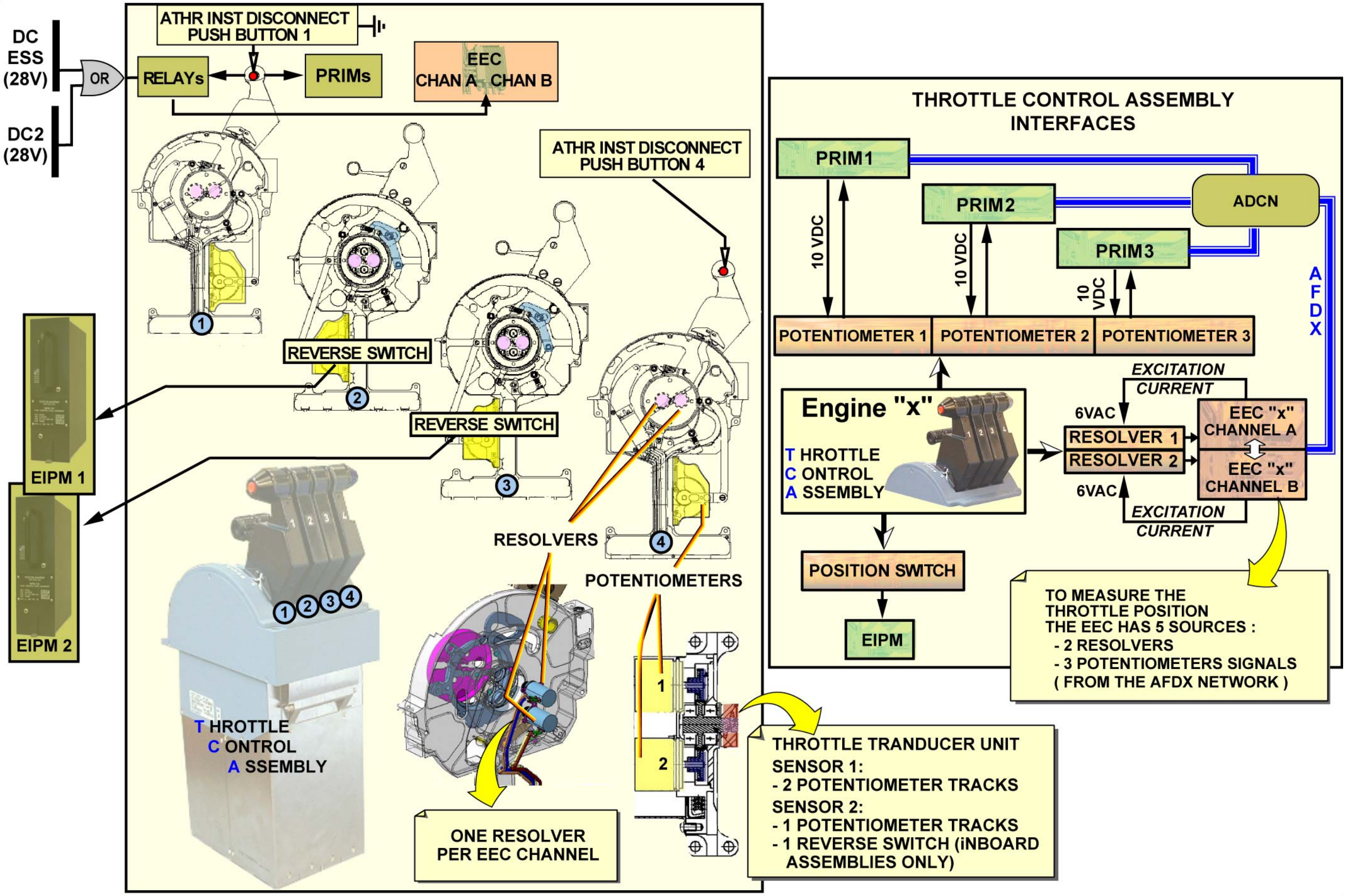
Modulation of engine thrust and selection of the thrust limit mode are achieved by using the throttle lever position sent by resolvers and potentiometers.
For each throttle control lever:
- Each of the two resolvers transmits the angle information of the throttle control lever to a channel of the Electronic Engine Control (EEC) (cross-communicated to the other channel).
The EEC supplies 6 VAC power to the resolvers.
- Each potentiometer transmits the angle information of the throttle control lever to a PRIMary system (PRIM).
The PRIM supplies 10 VDC power to the potentiometers
For each thrust reverser lever:
The reverse position switch sends a discrete signal via the Engine Interface Power Management (EIPM) to control the Engine Thrust Reverser Actuator Controller (ETRAC) power.
In addition to the two resolvers signal, the EEC receives, via the AFDX network, three digital throttle angle values coming from the three PRIMs.
PRIM potentiometer information is used to consolidate resolver signal selection.

Selection Logic of the Throttle Control Lever Position

To measure the position of the throttle control lever, the EEC has 5 sources:
- 2 Resolvers (one analog signal per channel, cross-communicated to the other channel).
- 3 Potentiometers signals (sensed by Flight Controls Primary Computers) received from AFDX Network.
Based on the 5 sources of throttle position, the EEC does the following selection logic:
The EEC validates (range & consistency checks) all resolver and potentiometers signals.
The resolvers are selected if they are both validated and both agree with each other (digital information from potentiometers is disregarded).
When both resolvers are in disagreement, then the potentiometers are used as a referee to identify which resolver has failed.
Then, the EEC selects the valid resolver.
If there is disagreement between a single resolver and the potentiometers, then potentiometers are selected (via AFDX).

Instinctive Disconnect Pushbutton Interface

The disengagement of the A/THR function can be manually done through action on the instinctive disconnect pushbuttons on the throttle levers.
Both Instinctive Disconnects (A/THR disengagement) are directly hardwired to each EEC through relays.
The EEC receives also this signal as AFDX information from the PRIMs.
The FADEC autothrust function is inhibited until the next EEC reset, if the autothrust instinctive disconnect signal is asserted continuously for more than 15 seconds.
The DC ESS and DC 2 bus bar supply 28 VDC power to the relays associated to the instinctive disconnect pushbuttons.


DC ESS (28V)
DC2 (28V)
OR
RELAYs
ATHR INST DISCONNECT PUSH BUTTON 1
PRIMs
EEC
CHAN A
CHAN B
ATHR INST DISCONNECT PUSH BUTTON 4
1
2
3
4
REVERSE SWITCH
REVERSE SWITCH
EIPM 1
EIPM 2
RESOLVERS
POTENTIOMETERS
THROTTLE CONTROL ASSEMBLY
1
2
THROTTLE CONTROL ASSEMBLY INTERFACES
PRIM1
PRIM2
PRIM3
ADCN
AFDX
10 VDC
10 VDC
10 VDC
POTENTIOMETER 1
POTENTIOMETER 2
POTENTIOMETER 3
EXCITATION CURRENT
6VAC
RESOLVER 1
RESOLVER 2
6VAC
EXCITATION CURRENT
EEC "x" CHANNEL A
EEC "x" CHANNEL B
Engine "x"
THROTTLE CONTROL ASSEMBLY
POSITION SWITCH
EIPM

ONE RESOLVER PER EEC CHANNEL

THROTTLE TRANDUCER UNIT
SENSOR 1:
- 2 POTENTIOMETER TRACKS
SENSOR 2:
- 1 POTENTIOMETER TRACKS
- 1 REVERSE SWITCH (iNBOARD ASSEMBLIES ONLY)

TO MEASURE THE THROTTLE POSITION THE EEC HAS 5 SOURCES :
- 2 RESOLVERS
- 3 POTENTIOMETERS SIGNALS (FROM THE AFDX NETWORK)

THROTTLE CONTROL ASSEMBLY INTERFACES - SELECTION LOGIC OF THE THROTTLE CONTROL LEVER POSITION & INSTINCTIVE DISCONNECT PUSHBUTTON INTERFACE

THRUST CONTROL DESCRIPTION (3)

Engine Power Philosophy

The engine thrust is the result of several cockpit settings. To meter the fuel flow, according to its own laws, the Electronic Engine Control (EEC) takes into account:
-The throttle control levers position,
-The Auto Flight System (AFS) command,
-The Keyboard and Cursor Control Unit (KCCU) take-off data input by the flight crew.
The command signals and other relevant input signals are processed within the EEC.
EEC output control signals are transmitted to the engine Fuel Metering Unit (FMU) to be converted in fuel flow and through the ACUTE (Airbus Cockpit Universal Thrust Emulator) for indication of the thrust parameters. The EEC sends to the CDS (Control and Display System) the thrust that must be indicated via the Aircraft AFDX network (ADCN).

Manual thrust And Autothrust

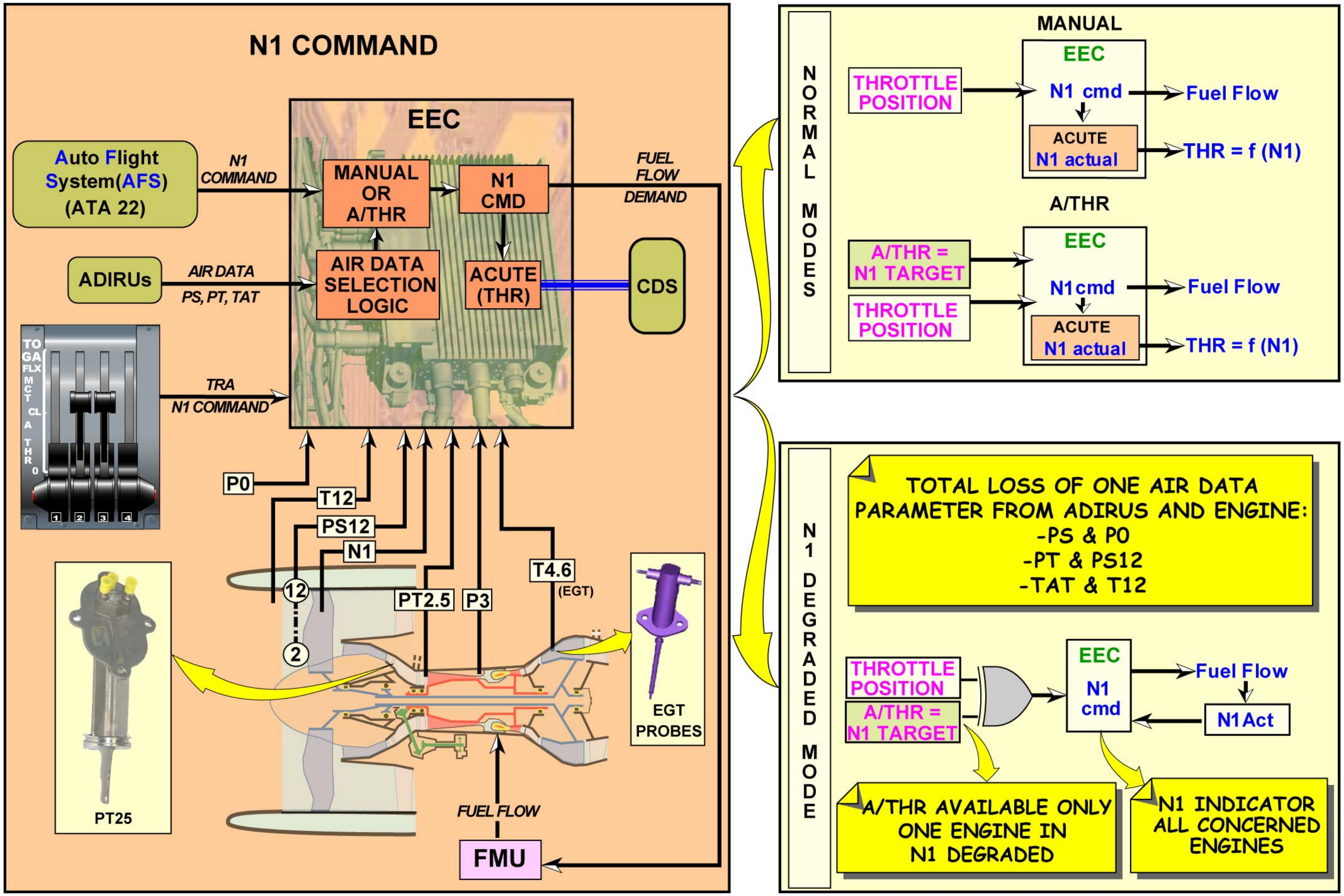
Two thrust setting modes are used in order to obtain the required thrust: manual and automatic modes.
In the manual mode, the EEC receives a command signal, the Throttle Resolver Angle (TRA), to set the thrust.
Alternatively, when the AutoTHRust (A/THR) is activated, the EEC sets the thrust by taking into account:
- The N1 target from the AFS and,
- The TRA, for the thrust limitation and to display the thrust limit mode.
In autothrust mode, the EEC uses, the throttle control lever position to limit the maximum thrust, which can be commanded by the AFS, except when ALPHA FLOOR protection is commanded. The EEC uses the TRA related to the detent points of the throttle control levers to determine the thrust limit mode.
During Take-Off the A/THR function is engaged but not active.

Memo Thrust Mode

This is a transitive mode of thrust control between autothrust mode and manual mode. Memo mode is selected as a result of automatic deactivation of autothrust mode. In this mode, the EEC locks N1 at the level it was before exiting autothrust mode. This is achieved by recording N1 ACTUAL during autothrust mode. On entry into memo mode, the engine command shall be set to the last recorded value of N1 ACTUAL.
The philosophy behind the memo mode of thrust control is to prevent potential thrust step changes, which may occur when transitioning from autothrust mode to manual mode.

N1 Degraded Mode

The EEC reverts to N1 degraded mode operation when it is unable to determine the ambient conditions through the Air Data Inertial Reference Units (ADIRUs) and the engine sensors.
Reversion to N1 degraded mode shall be automatic, when a loss of one of these couples of air data parameters occurs:
- PS (ADIRUs) and P0 (engine),
- PT (ADIRUs) and PS12 (engine),
- TAT (ADIRUS) and T12 (engine),
for at least 2 seconds.
Reversion to N1 degraded mode will be followed by appropriate ECAM warnings. The EEC sends to the Cockpit Display System (CDS) the "N1_Unrated" parameter for display. When the EEC reverts to N1 degraded mode, the CDS will replace the ACUTE THR indicator with the N1 indicator.
Once the conditions to set N1 degraded mode are met, the EEC shall latch N1 degraded mode operation. Degraded mode is not cleared even if air data inputs are restored. N1 degraded mode shall be reset following a MASTER lever reset.


N1 COMMAND
EEC
Auto Flight System(AFS) (ATA 22)
N1 COMMAND
MANUAL OR A/THR
N1 CMD
FUEL FLOW DEMAND
ADIRUs
AIR DATA
PS, PT, TAT
AIR DATA SELECTION LOGIC
ACUTE (THR)
CDS
TO GA FLX MCT CL A THR 0
1 2 3 4
TRA
N1 COMMAND
P0
T12
PS12
N1
T4.6
(EGT)
12
2
PT2.5
P3
EGT PROBES
PT25
FUEL FLOW
FMU
NORMAL MODES
MANUAL
THROTTLE POSITION
EEC
N1 cmd
ACUTE
N1 actual
Fuel Flow
THR = f (N1)
A/THR
A/THR = N1 TARGET
THROTTLE POSITION
EEC
N1cmd
ACUTE
N1 actual
Fuel Flow
THR = f (N1)
N1 DEGRADED MODE
THROTTLE POSITION
A/THR = N1 TARGET
EEC
N1 cmd
Fuel Flow
N1Act

TOTAL LOSS OF ONE AIR DATA PARAMETER FROM ADIRUS AND ENGINE:
-PS & P0
-PT & PS12
-TAT & T12

A/THR AVAILABLE ONLY ONE ENGINE IN N1 DEGRADED

N1 INDICATOR ALL CONCERNED ENGINES

ENGINE POWER PHILOSOPHY - MANUAL THRUST AND AUTOTHRUST ... N1 DEGRADED MODE

THRUST CONTROL DESCRIPTION (3)

Air Data Selection Logic

The engine sensor values are compared to the ADIRU values.
In normal operation, ADIRU values are used. The engine sensor values will be used as backup in case of failure.
Engine signals (P0, PS12/PT2 and T12) are compared by the EEC to the three ADIRUs signals (PS, PT and TAT). These signals are compared via the AFDX network to be used as Input for the air data selection logic.
Engine P0 is measured by a single transducer, which is installed in the EEC. The transducer measures the pressure P0 air pressure from Zone 1 as under-cowl pressure environment.
The engine air data selection logic compares the three parameters (P0, PS12 and T12) of the EEC with the three ADIRU parameters, which are:
-PS (static pressure) equivalent to engine P0,
-PT (total pressure) equivalent to engine PS12,
-TAT (Total Air Temperature) equivalent to engine T12
The 3 ADIRUs plus the 4 EECs give a total of 7 available sources that are compared and validated through the AFDX network, to compute the N1 command.

Autothrust Control

The AFS interfaces with the FADEC to give the autothrust function, including the ALPHA FLOOR protection.
The Autothrust function can be engaged or disengaged according to the logic implemented in the PRIMs computers. When engaged, the function is either active or not active.
Once engaged and active, the EEC uses the AFS N1 target to set the engine power level. In normal mode, even if the A/THR sends an N1 target to the engine, the THR is computed from N1 and air data parameters.

Autothrust Function Engagement / Disengagement / Activation

The engagement of the autothrust function can be accomplished manually or automatically.
The autothrust function can be engaged manually through the A/THR pushbutton of the FCU.
The autothrust is automatically engaged but not active when the throttle control levers are set to TOGA or FLX detent with aircraft on the ground.
The autothrust will become active at the thrust reduction altitude when the pilot will move the throttle control levers to CLimb detent.
If the Alpha FLOOR protection is activated the autothrust is automatically engaged and active and it orders TOGA thrust for all engines.
The disengagement of the autothrust function can be achieved:
- Manually via the instinctive disconnect pushbuttons installed on the ENG 1 & 4 throttle control Levers (normal operation),
- Manually through the FCU autothrust pushbutton, memo mode (thrust lock),
- Automatically when the 4 throttle control levers are selected at idle,
- Automatically when the 2 thrust reverser levers are selected to reverse,
- Automatically when more than 1 engine is not in A/THR mode,
- Automatically in case of more than 1 engine failure,
- Automatically in case of failure seen by the AFS.

In case of autothrust disengagement, each engine is controlled in manual mode, or in memo mode in the case of involuntary disconnection.
When Autothrust is engaged it can be:
- Active: throttle control levers between 0 (idle) and CL (or MCT with one engine failure) and at least one throttle control lever at or below

CL (with no engine failure). Thrust is controlled by the A/THR function.
- Not active: if all throttles are above CL (or above MCT with one engine failure). Thrust is controlled according to the throttle position.

ALPHA FLOOR: Autothrust Activation

In case of ALPHA FLOOR detection the A/THR is automatically activated and commands the TO/GA thrust mode, regardless of the throttle control lever position.

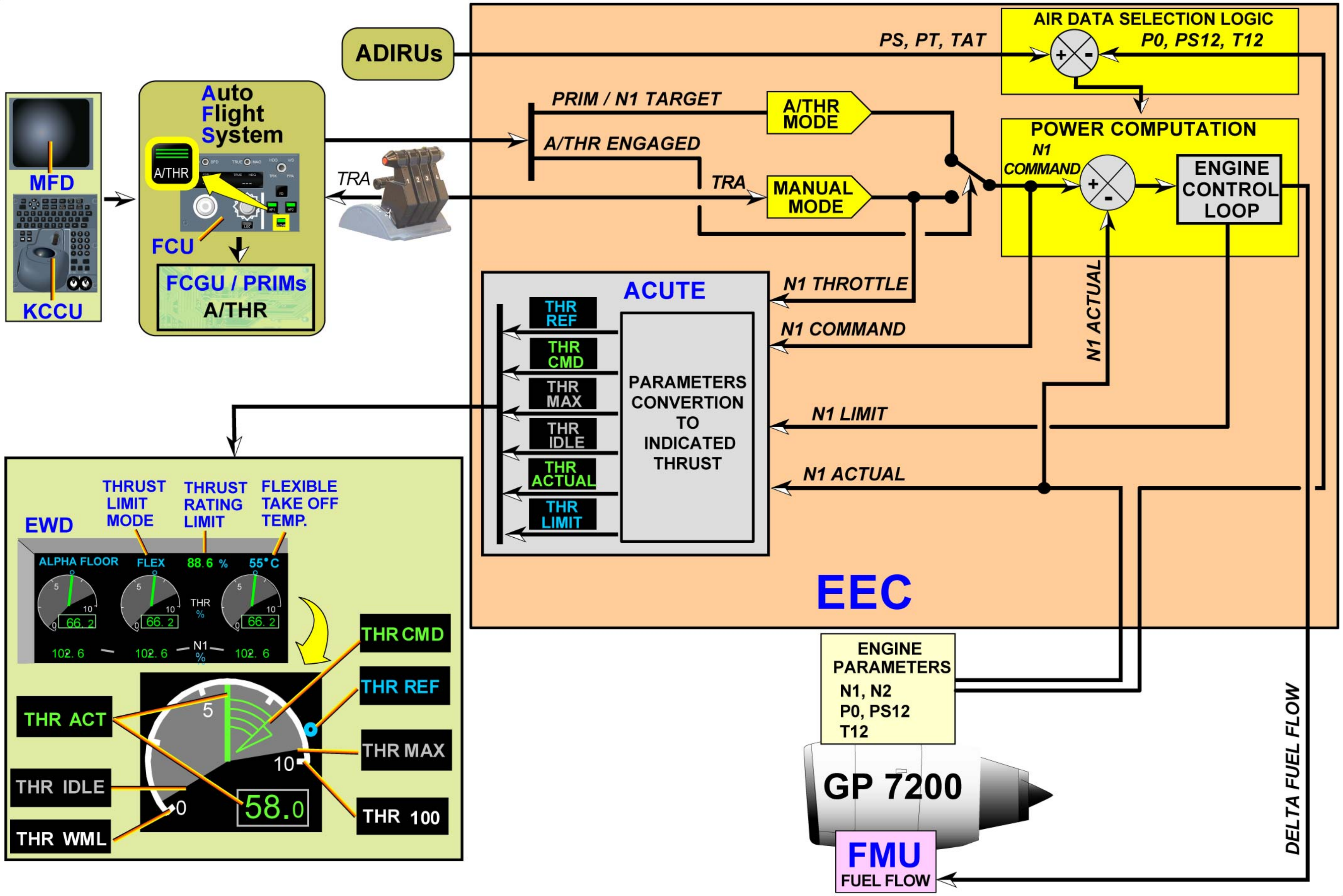
Cockpit Thrust Display (ACUTE)

ACUTE (AIRBUS Cockpit Universal Thrust Emulator) is a percentage indication of thrust.
The ACUTE function calculates percentage parameters from engine command and thrust feedback parameters, for cockpit display on EWD
The parameters are:
- THR Limit,
- THR Actual,
- THR Command,
- THR REF (position of the throttle control lever),
- THR Idle,
- THR Max.

THR WML: Thrust wind milling (0%)
THR 100: Thrust 100 is the THR achieved when throttle is at TOGA and Bleed Off (100%).
THR REF: Thrust ref is the THR corresponding to the position of the throttle control lever
THR CMD: Thrust command is the THR target commanded by the PRIMs when A/THR is active.
THR IDLE: Low-end of grey sector agrees with the THR achieved when the engine is operating at Idle.
THR MAX: High-end of grey sector agrees with the THR achieved when the throttle control lever is set at TOGA detent.
THR ACTual: RAW engine thrust corrected by engine drag.
The parameters THR100, THR Limit, THR Actual, THR Command, THR Throttle, THR Idle, THR MAX, are sent to the airframe CDS through the AFDX network.
When operating in degraded N1 mode, the thrust parameters are replaced by the N1 parameters on the EWD.

Thrust Limit Modes and Thrust Rating Limit

The thrust limit mode (Max CL, Derated Climb, Derated Take-Off, FLEXible take off, MTO, MCT, GA, FlexGA), is determined by the detent points of the throttle control levers. When the throttle control lever is between two detent points, the most advanced detent point is taken into account.
The common displayed thrust limit mode is the highest "thrust limit mode" of the four engines.
The "thrust rating limit" is thrust value available in the displayed "thrust limit mode".


ADIRUs
PS, PT, TAT
AIR DATA SELECTION LOGIC
P0, PS12, T12
+
-
MFD
KCCU
Auto
Flight
System
A/THR
FCU
FCGU / PRIMs
A/THR
TRA
PRIM / N1 TARGET
A/THR ENGAGED
A/THR MODE
TRA
MANUAL MODE
POWER COMPUTATION
N1
COMMAND
+
-
ENGINE CONTROL LOOP
ACUTE
THR REF
THR CMD
THR MAX
THR IDLE
THR ACTUAL
THR LIMIT
PARAMETERS CONVERTION TO INDICATED THRUST
N1 THROTTLE
N1 COMMAND
N1 ACTUAL
N1 LIMIT
N1 ACTUAL
EEC
EWD
THRUST LIMIT MODE
THRUST RATING LIMIT
FLEXIBLE TAKE OFF TEMP.
ALPHA FLOOR
FLEX
88.6 %
55°C
THR
%
N1
%
66.2
66.2
66.2
102.6
102.6
102.6
THR CMD
THR REF
THR MAX
THR 100
THR ACT
THR IDLE
THR WML
5
10
0
58.0
ENGINE PARAMETERS
N1, N2
P0, PS12
T12
GP 7200
FMU
FUEL FLOW
DELTA FUEL FLOW

AIR DATA SELECTION LOGIC ... COCKPIT THRUST DISPLAY (ACUTE)

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FADEC ARCHITECTURE & INTERFACE DESCRIPTION (3)

FADEC Overview

The Full Authority Digital Engine Control (FADEC) system, together with aircraft systems, gives the control for engine starting, shut down, power management and engine indicating. The FADEC system is controlled and monitored by an Electronic Engine Control (EEC). The EEC is a dual channel digital unit. The EEC reads inputs from the aircraft systems and the engine systems and provides engine control and cockpit indications.

Output data from the channel A of the EEC is sent to the Engine Interface Power Management (EIPM) computer via an ARINC 429 bus, for Back-up function.

Each channel of the EEC receives its own Throttle Resolver Angle (TRA) analog signal from the Throttle Control Assembly, independently from the AFDX network through two dedicated resolvers.

The Autothrust (A/THR) instinctive disconnect discrete signal is directly hardwired to each channel of the EEC. Both A/THR instinctive disconnect P/Bs are used by the flight crew to disengage the A/THR mode on all engines.

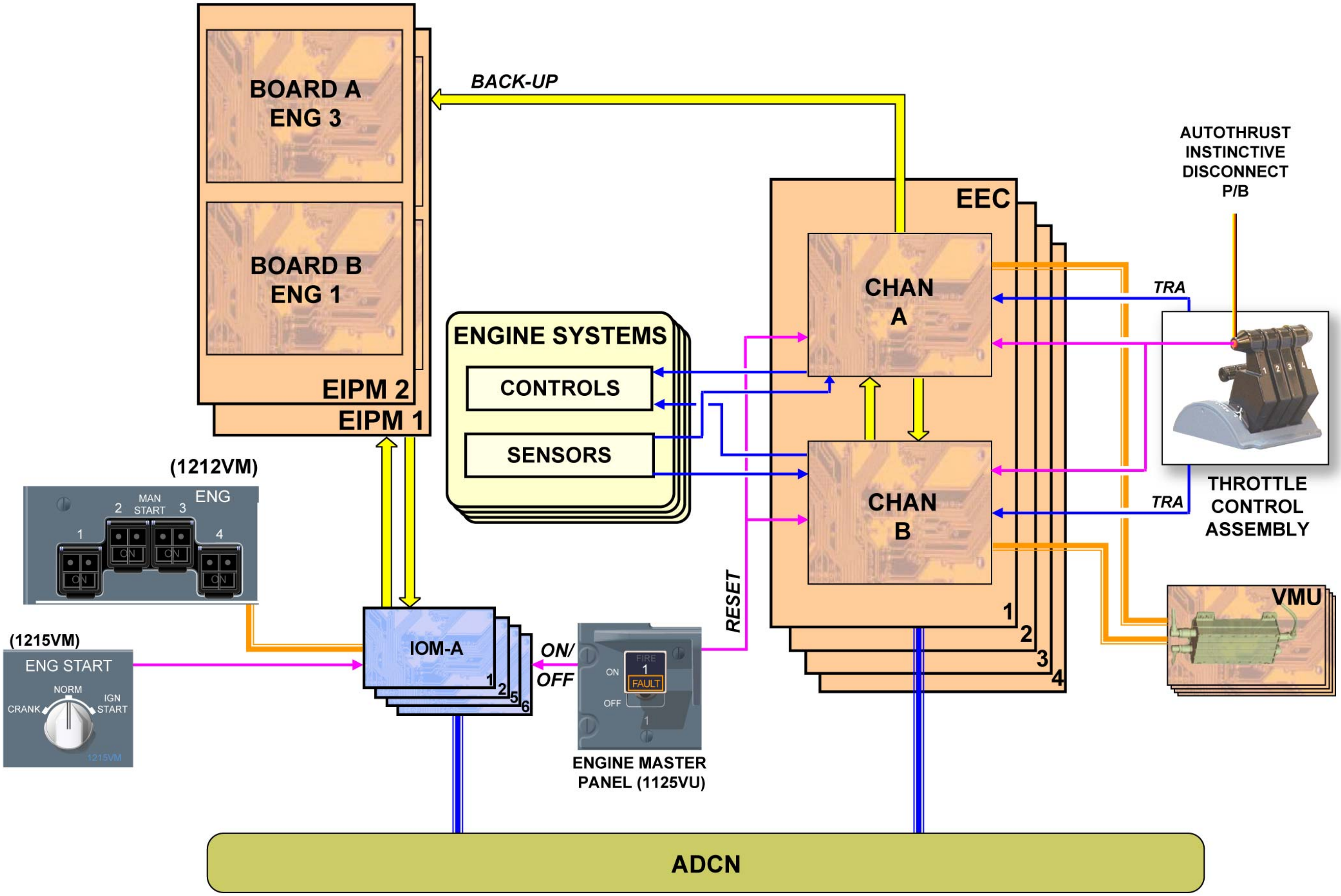
The EEC exchanges data with the Vibration Monitoring Unit (VMU). The VMU analyses data from accelerometers and tachometers.The VMU gives a report on the engine vibrations. Some processed data are sent from the VMU to the EEC for cockpit display.

EEC acquires the following signals from cockpit panels, through 4 IOMS and the Avionics Data Communication Network (ADCN):

- ENGine START selector, CRANK/NORM/IGN START position
- ENG MAN START push button switches status
- MASTER lever position ON/OFF (one per engine), to initiate the Engine Starting sequence (in Automatic Start) or to turn the fuel on (in Manual Start or Wet crank).

A discrete signal is directly hardwired from the ENGine MASTER lever to each channel of the EEC for EEC reset, and to keep the ENG MASTER lever position in case of AFDX failure.

The ENG MASTER lever FAULT light is managed by the EIPM, based on digital data received from the related EECs (own and opposite), via the 4 IOMs.


BOARD A
ENG 3
BOARD B
ENG 1
EIPM 2
EIPM 1
BACK-UP
AUTOTHRUST
INSTINCTIVE
DISCONNECT
P/B
EEC
CHAN
A
CHAN
B
TRA
TRA
ENGINE SYSTEMS
CONTROLS
SENSORS
1
2
3
4
THROTTLE
CONTROL
ASSEMBLY
VMU
RESET
(1212VM)
ENG
MAN
START
1
2
3
4
ON
(1215VM)
ENG START
NORM
CRANK
IGN
START
1215VM
IOM-A
1
2
5
6
ON/
OFF
FIRE
FAULT
ON
OFF
ENGINE MASTER
PANEL (1125VU)
ADCN

FADEC OVERVIEW

FADEC ARCHITECTURE & INTERFACE DESCRIPTION (3)

EEC Aircraft Interfaces

EEC has digital interfaces, analog and discrete inputs/outputs.

EEC Digital Interfaces

The four EECs have digital interfaces with the aircraft systems through the ADCN.

The IOMs transmit cockpit commands (MASTER Lever, START rotary selector, MANual START P/B), the EIPM and the Anti-Ice Control Unit (AICU) data to the EEC.

The EIPMs receive, via the IOM, engine status data (speed, starting, shutdown, reverse inhibition, reverse locked...) from the EEC own and opposite data busses and sends to the EEC electrical power supply (EEC channel, igniters, Electronic Thrust Reverser Actuation Controller (ETRAC), Thrust Reverser Actuation System (ETRAS)).

The Anti-Icing Control Unit (AICU) receives, via the IOM, data on:
- Engine running,
- Maximum take off/go around, flex take off and derated take off limit mode selected,
- Nacelle Anti-Ice (NAI) valve position feedback.

The AICU sends to the EEC:
- Wing Anti-Ice (WAI)/NAI status for engine thrust modulation,
- NAI command.

The Engine Bleed Air System (EBAS), the Pneumatic Air Distribution System (PADS) and the Overheat Detection System (OHDS) are hosted in CPIOM-A. Those systems receive data from the EEC concerning:
- Engine status (engine starting and running, reverse operation) and starting information for Pack closure,
- Engine pressure & temperatures
- Starter Air valve (SAV) position.

The EBAS, the PADS and the OHDS send data to the EEC concerning:
- Bleed configuration status,
- HP/IP Command (TBC),
- Bleed manifold Pressure,
- Cross-bleed valves position,
- APU isolation valve.

The Avionics Ventilation System (AVS), the Air Generation System (AGS) and the Cabin Pressure Control System (CPCS) are hosted in the CPIOM-B (AVS hosted in B3 and B4). The AVS receives data from the EEC concerning the Engine Status (engine running / not running). The CPCS receives data from the EEC concerning the engine running, the engine take-off power and the N1 speed. The AGS receives engine starting information for the pack closure demand of the pack valves from the EEC.

The Flight Warning System (FWS) is hosted in CPIOM-C: It receives engine failures warning annunciation and engine status (speed, starting, shutdown, reverse operation) from the EEC via the ADCN and from EIPM in back up with ARINC 429 bus. The AGS sends to the EEC data concerning the ECS pack flow demand and the pack command push-button.

The Air traffic Control (ATC) is hosted in CPIOM-D1 and receives data from the EEC on engine status (engine running, not running, etc.).

The Fuel Quantity Management System (FQMS) is hosted in CPIOM-F: It receives fuel used data from the EEC.

The Landing Gear Extension Retraction System (LGERS) is hosted in CPIOM-G: It sends wing and body landing gears status (for flight/ground status computation) to the EEC.

The Doors and Slides Management System (DSMS) receives engine running data from the EEC.

The Electrical Power Generating System (EPGS) receives data from the EEC on the engine status (MASTER lever OFF, Engine START / CRANK sequence active) and on engine speed N2.

The PRIM (Flight controls and Guidance Computer) receives Engine status (speed, starting, shutdown, reverse operation) and autothrust

feedbacks (actual thrust, commanded thrust, thrust limits, etc.) from the EEC. It sends to the EEC:
- Autothrust command,
- Autothrust engaged and active signals,
- Alpha floor protection,
- Throttle position (for consolidation of EEC signals from potentiometers),
- T/O mode selection input (Flex temperature, Derated T/O levels, Derated Climb levels),
- Thrust Control Malfunction (TCM) permission discrete command,
- Wheel speed (provision).

The Aircraft Environment Surveillance System (AESS) receives engine running, selected take off power and thrust data from the EEC.

The Air data and Inertial reference System (ADIRS) receives engine data from the EEC for consolidation of ADIRU internal parameters.

The ADIRS sends air data parameters (static pressure, total pressure, TAT, Mach number) and probe heat status (pitot, static, TAT, AOA) to the EEC.

The ECB (APU controller) receives start sequence signal for the APU boost from the EEC and sends APU availability signal (for bleed configuration determination) to the EEC.

The Slat/Flap Control Computer (SFCC) sends slat/flap configuration (for approach selection) to the EEC.

The Weight and Balance Back-up Computer (WBBC) receives data on fuel used from the EEC.

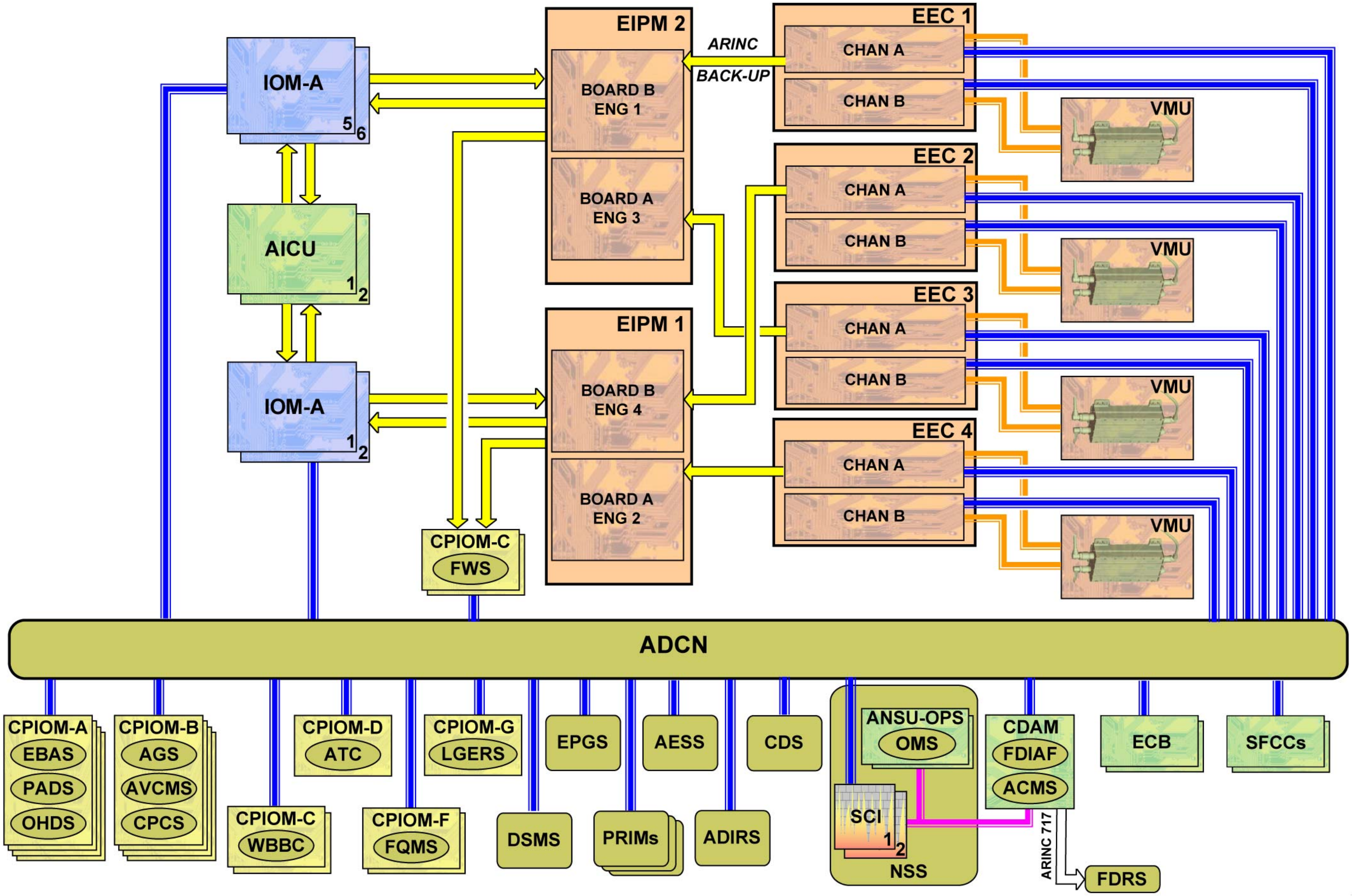
The Command and Display System (CDS) receives from the EEC:
- Engine primary parameters (ACUTE, N1, Fuel Flow (FF), Exhaust Gas Temperature (EGT),
- Engine secondary parameters (N2, Fuel used, oil pressure, oil quantity, vibration levels),
- Engine status (speed, starting, shutdown, reverse operation).

The Aircraft Condition Monitoring System (ACMS) and the Flight Data and Interface Function (FDIAF) are hosted in the Centralized Data Acquisition Module (CDAM). Those systems receive engine data for performance and trend monitoring and engine manufacturer's reserved parameters.

The Flight Data Recording System (FDRS) receives data from the EEC, through the CDAM, concerning:
- P3, Regulated Pressure, Engine bleed demand factors,
- N1 limit, N2,
- Each thrust reverser position, and throttle control lever position,
- EGT, oil quantity, engine vibration, oil temperature, and oil pressure,
- HP/LP fuel valve,
- Fuel flow, and derated take-off,
- Positive engine relight indication,
- Thrust command,
- Engine warning (each engine vibration),
- Thrust/Power on each engine.

The CDAM transmits its data to the OMS (Onboard Maintenance System).

The OMS application interfaces with ADCN through the Secure Communication Interface (SCI) data.


EIPM 2
BOARD B ENG 1
BOARD A ENG 3
ARINC
BACK-UP
EEC 1
CHAN A
CHAN B
EEC 2
CHAN A
CHAN B
EEC 3
CHAN A
CHAN B
EEC 4
CHAN A
CHAN B
VMU
VMU
VMU
VMU
IOM-A
5
6
AICU
1
2
IOM-A
1
2
EIPM 1
BOARD B ENG 4
BOARD A ENG 2
CPIOM-C
FWS
ADCN
CPIOM-A
EBAS
PADS
OHDS
CPIOM-B
AGS
AVCMS
CPCS
CPIOM-C
WBBC
CPIOM-D
ATC
CPIOM-F
FQMS
CPIOM-G
LGERS
DSMS
EPGS
PRIMs
AESS
ADIRS
CDS
ANSU-OPS
OMS
SCI
1
2
NSS
CDAM
FDIAF
ACMS
ARINC 717
FDRS
ECB
SFCCs

EEC AIRCRAFT INTERFACES - EEC DIGITAL INTERFACES

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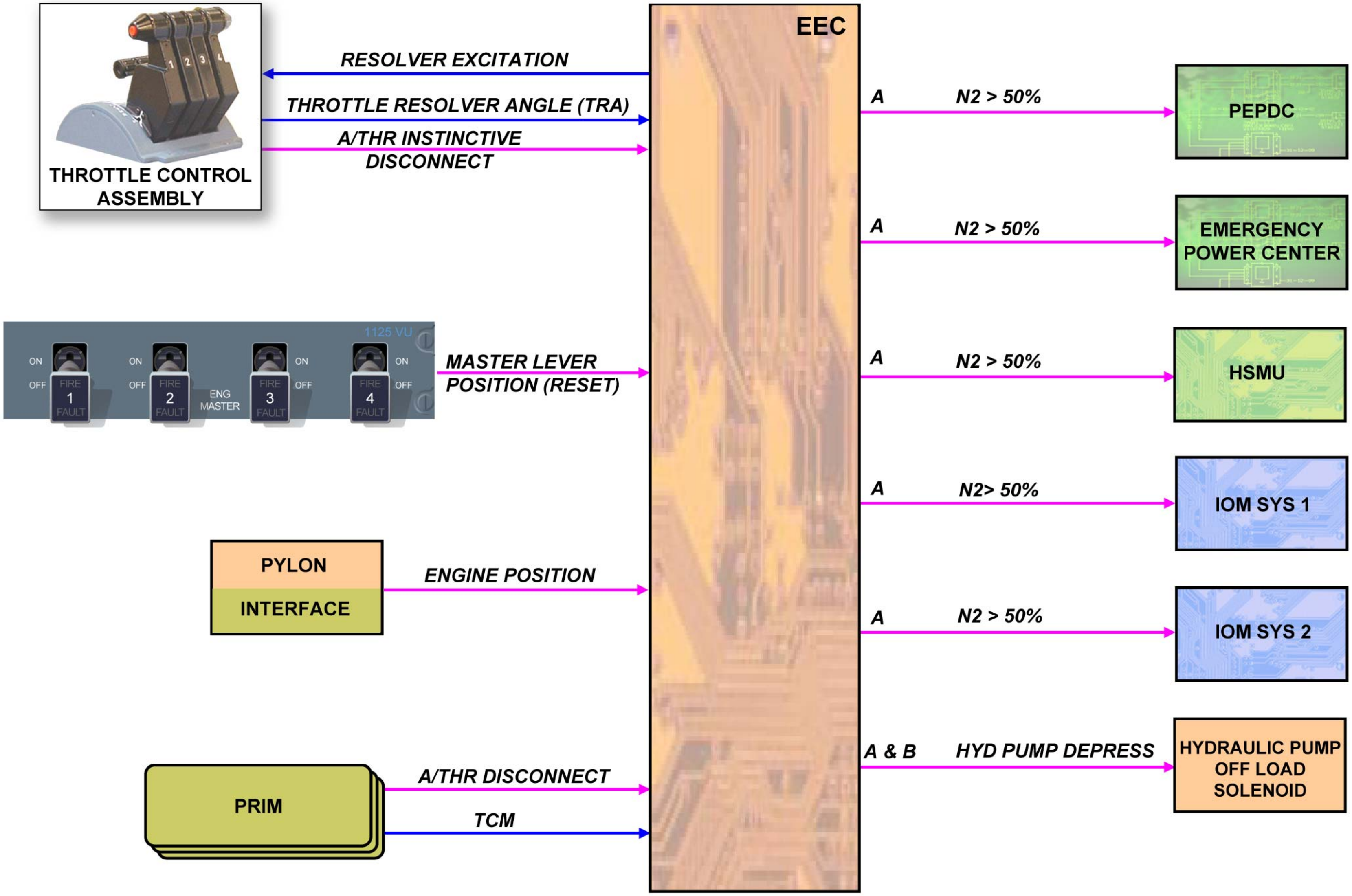
FADEC ARCHITECTURE & INTERFACE DESCRIPTION (3)

EEC Aircraft Interfaces (continued)

EEC Analog and Discrete Inputs/Outputs

The EEC has direct interfaces with aircraft systems and cockpit controls. It receives and sends analog and discrete data.
Control of the engines is achieved by modulation of a throttle lever angle.
The Throttle Control Assembly (TCA) receives the excitation current for the resolvers from each channel of the EEC.
The Throttle Resolver Angle (TRA) of the throttle lever position is transmitted by analog signals to each channel of the EEC.
A discrete signal from the ENG MASTER lever is directly hardwired to each channel of the EEC, for EEC reset function.
The activation of the A/THR instinctive disconnect P/B is used to disengage the A/THR mode on all engines. An A/THR instinctive disconnect discrete signal is directly hardwired to one EEC channel (internally cross-wired) as well as to the Flight Controls Computers (PRIMs) and to the Flight Warning System.
In order for the Engine Control System to protect against Thrust Control Malfunction (TCM), an independant discrete signal from the aircraft is directly hardwired to each EEC. The function of this independant input is to authorize the EEC to shut the engine down if it has detected an uncommanded and uncontrollable thrust excursion, which may affect the aircraft controllability. The TCM protection signal is set by the Flight Controls PRIMary (PRIM).
Each EEC receives from the Airframe hardwired discretes indicating position on the aircraft. These discretes are directly hardwired from the Pylon junction box to the EEC.
When engine speed is detected to be higher than 50% N2, both EEC channels set the engine running discrete output. However, only the output from the channel A is planned to be acquired on the aircraft side by the IOMs 1 and 2, the Emergency Power Center, the Primary Electrical Power Distribution Center (PEPDC) and the Hydraulic System Monitoring Unit (HSMU).
For engine in-flight wind milling restart functions, the EEC has the ability to depressurize both hydraulic pumps on the engine. To achieve this function, both EEC channels are able to switch one output ground/open discrete signal that commands the depressurization of both engine-driven hydraulic pumps.


THROTTLE CONTROL ASSEMBLY
RESOLVER EXCITATION
THROTTLE RESOLVER ANGLE (TRA)
A/THR INSTINCTIVE DISCONNECT
EEC
A
N2 > 50%
PEPDC
A
N2 > 50%
EMERGENCY POWER CENTER
ON
OFF
FIRE
1
FAULT
2
3
4
ENG MASTER
1125 VU
MASTER LEVER POSITION (RESET)
A
N2 > 50%
HSMU
A
N2> 50%
IOM SYS 1
PYLON
INTERFACE
ENGINE POSITION
A
N2 > 50%
IOM SYS 2
A & B
HYD PUMP DEPRESS
HYDRAULIC PUMP OFF LOAD SOLENOID
PRIM
A/THR DISCONNECT
TCM

EEC AIRCRAFT INTERFACES - EEC ANALOG AND DISCRETE INPUTS/OUTPUTS

FADEC ARCHITECTURE & INTERFACE DESCRIPTION (3)

EEC Command and Sensor Interfaces

The FADEC does engine control and monitoring.
The Data Entry Plug (DEP) gives engine specific performance and configuration information. The DEP is a plug and housing, which is fastened to the engine by the use of a lanyard. DEP is only programmed with the applicable data for the engine on which it is installed. It cannot be removed and then installed to a different engine unless it is programmed for that engine.
The DEP includes the following data:

- Engine serial number
- Rating thrust,
- N1 trim level,
- Engine rating selection,
- Bump rating,
- Engine hardware configuration.

NOTE: If the DEP data and the engine data are not consistent, the engine will not operate normally.

The fuel flow XMTR continuously monitors the fuel flow to the combustion system. The XMTR supplies analog signals to the EEC that are in proportion to the mass fuel flow rate. The EEC uses these signals to calculate the flow rate and the quantity of fuel that has been used. The EEC then transmits this data for display in the cockpit.
The fuel filter differential pressure sensor indicates to the EEC if the fuel filter is becoming clogged.
The fuel strainer differential pressure sensor indicates to the EEC if the fuel pump strainer is becoming clogged.
The oil quantity XMTR is installed on top of the oil tank. The EEC uses this signal for display in the cockpit.
The oil pressure sensor is located on the right hand side of the engine in the main oil supply line. The oil pressure sensor measures the absolute pressure of the main oil supply system. The output is conditioned and monitored by the EEC and displayed on the cockpit display system.
The oil temperature sensor is attached to the elbow of the oil scavenge line which attaches to the oil scavenge pump discharge port. It is a resistive temperature device. The output is conditioned and monitored by the EEC.
The main oil filter has a differential pressure sensor, which is used to determine if the primary oil filter element is clogging.
The oil debris monitoring sensor is part of the air/oil separator at the top of the oil tank. The sensor is an electronic master chip detector for the engine oil system. Ferrous metal particles are collected on the sensor and an electronic signal is generated when particles are captured. The signal is sent to the EEC via the Oil Debris Monitoring (ODM) signal conditioner.
The T12 sensor is mounted on the nacelle inlet cowl. It gives the temperature of the fan inlet air to the EEC to be used in the engine control algorithms.
The T2.5 sensor is mounted on the fan hub frame. It gives the temperature at engine station 2.5, between the Low Pressure Compressor (LPC) (booster) discharge and High Pressure Compressor (HPC) inlet, to the EEC to be used in the engine control algorithms.
The Exhaust Gas Temperature (EGT) probe has two ungrounded, Type K thermocouple elements. The thermocouple probe junctions are at different depths to better average the gas path temperature. Signals from the thermocouple elements are averaged at the probe and the probes are processed in the EEC to give an averaged temperature output. There are eight probes, located at the second stage of the Low Pressure Turbine (LPT) inlet (Station 4.6) to obtain the temperature profile around the engine circumference.
Nacelle temperature is given by a T core sensor that contains two separate type K thermocouple junctions for redundancy. The output signals are averaged. Therefore, even if one thermocouple fails and the circuit resistance changes, the indicated temperature will not change. The

averaged sensor signal is a single signal that is split inside the EEC and sent to both EEC channels.

The N1 sensor is mounted at the end of the fan frame hub and goes through the No. 7 strut to sense the rotational speed of a ferromagnetic target wheel mounted on the fan shaft. The wheel has 43 teeth, of which one is low to let the VMU compute fan balancing solutions. It gives the engine fan speed to the aircraft for flight deck display and to the EEC for use in the engine control algorithms. In addition, the sensor sends signals for the VMU

The N2 speed sensor is installed on the side of the Angle Gearbox (AGB). It measures the speed of the lay shaft as it turns in the AGB. The speed of the lay shaft is in proportion to the engine core speed. The sensor has three isolated sensing coils, two for the EEC and one for the VMU.

P0: Each channel of the EEC contains an internal ambient pressure sensor. The local and cross channel

P12: The EEC receives dual redundant static pressure sensor signals from the air inlet at engine station 12.

The P2.5 gives the total pressure at engine station 2.5, between the LPC (booster) discharge and HPC inlet, to the EEC to be used in the engine control algorithms

P3: Compressor Discharge Static Pressure.

ECS pressure is picked on the HP bleed duct of the pneumatic system (ATA 36)

The EEC controls the starting system during the engine start sequence; the EEC opens the starter control valve to operate the pneumatic starter from either APU air, cross-bleed air or an external air source. The EEC receives feedback from the starter control valve position switch.

The EEC supplies the two ignition units (A and B) of the ignition system with 115 VAC aircraft power.

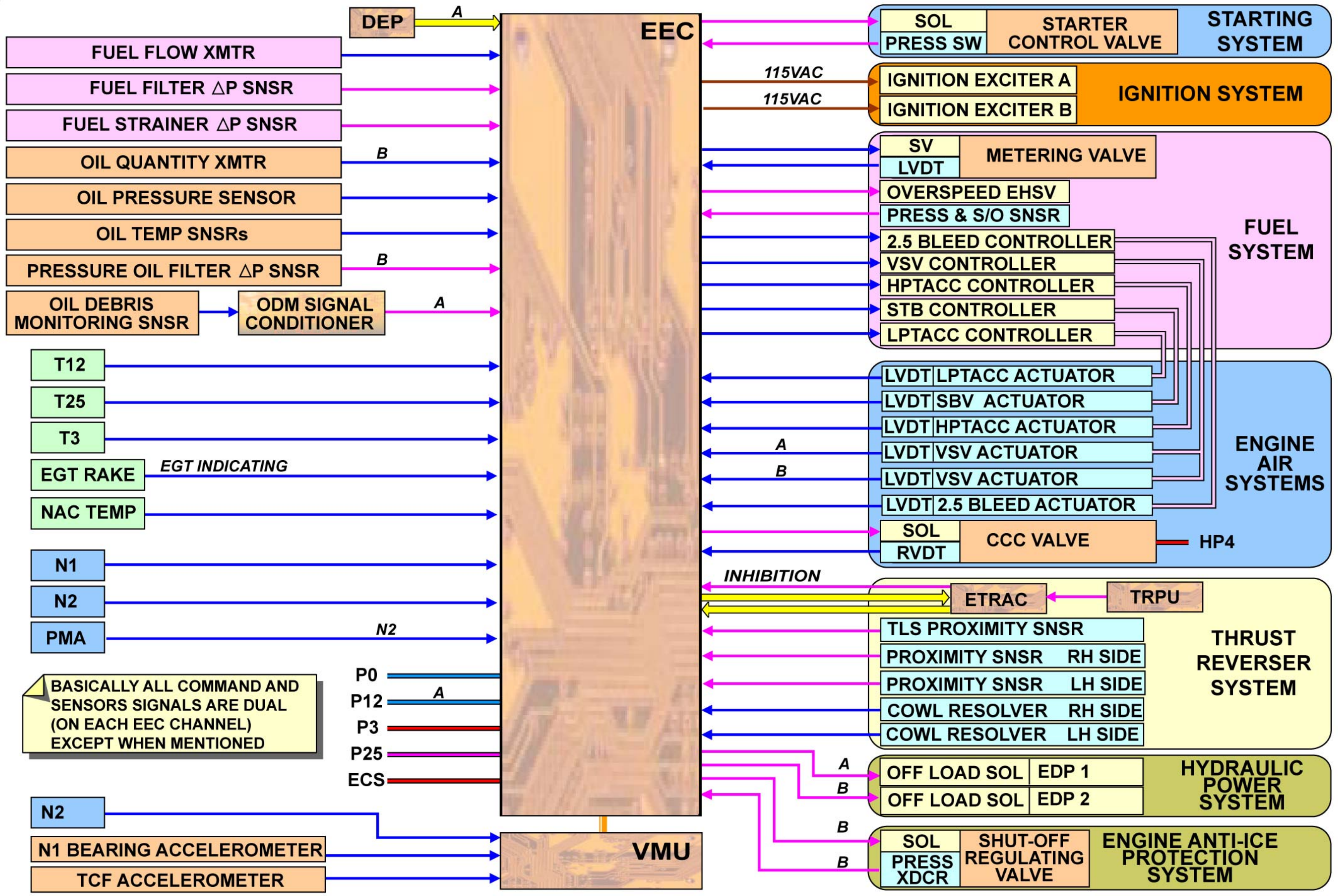
The EEC controls the fuel flow to the combustion system. The control elements are:

- The metering valve, which controls the rate of fuel flow (the EEC receives feedback from an Linear Variable Differential Transducer (LVDT)),
- The overspeed electro-hydraulic servo-valve,
- The PRESSure and Shut-Off valve (PRESS & S/O), which can stop the fuel flow and cause an engine shutdown in case of an overspeed (the feedback is given by the PRESS & S/O switch),
-The 2.5 BLEED servovalve, which supplies fuel to the 2.5 BLEED actuator (the EEC receives feedback from a LVDT located on the 2.5 BLEED actuator).
-The Variable Stator Vane (VSV) servovalve, which supplies fuel to the VSV actuators (the EEC receives feedback from a LVDT located on the VSV actuators).
-The High Pressure Turbine Active Clearance Control (HPTACC) servo-valve, which supplies fuel to the HPTACC actuator (the EEC receives feedback from a LVDT located on the HPTACC actuator).
-The start bleed valve servovalve, which supplies fuel to the start bleed valve actuator (the EEC receives feedback from a LVDT located on the starter bleed valve actuator).
-The Low Pressure Turbine Active Clearance Control (LPTACC) servo-valve, which supplies fuel to the LPTACC actuator (the EEC receives feedback from a LVDT located on the LPTACC actuator).
- The Core Compartment Cooling (CCC) valve closes when its solenoid is energized by the EEC. EEC receives feedback from an RVDT.

The EEC controls the Electronic Thrust Reverser Actuation Controller (ETRAC) through an ARINC 429 BUS. The Thrust Reverser Power Unit sends an inhibition signal to the EEC through the ETRAC. The EEC receives feedback from the Tertiary Locking System (TLS) proximity SNSRs, from the RH and LH proximity SNSRs and from the RH and LH side cowl resolvers.

The EEC controls the hydraulic pump off-load solenoids (channel A for EDP1 and channel B for EDP2) to depressurize the hydraulic system during an in-flight start.

The EEC channel B controls the engine anti-ice shut-off regulating valve via a solenoid. The EEC channel B receives feedback from the pressure transducer of the engine anti-ice shut-off regulating valve.


DEP
A
EEC
FUEL FLOW XMTR
FUEL FILTER ΔP SNSR
FUEL STRAINER ΔP SNSR
OIL QUANTITY XMTR
B
OIL PRESSURE SENSOR
OIL TEMP SNSRs
PRESSURE OIL FILTER ΔP SNSR
B
OIL DEBRIS MONITORING SNSR
ODM SIGNAL CONDITIONER
A
T12
T25
T3
EGT RAKE
EGT INDICATING
NAC TEMP
N1
N2
PMA
N2
BASICALLY ALL COMMAND AND SENSORS SIGNALS ARE DUAL (ON EACH EEC CHANNEL) EXCEPT WHEN MENTIONED
P0
P12
A
P3
P25
ECS
N2
N1 BEARING ACCELEROMETER
TCF ACCELEROMETER
VMU
SOL
PRESS SW
STARTER CONTROL VALVE
STARTING SYSTEM
115VAC
115VAC
IGNITION EXCITER A
IGNITION EXCITER B
IGNITION SYSTEM
SV
LVDT
METERING VALVE
OVERSPEED EHSV
PRESS & S/O SNSR
2.5 BLEED CONTROLLER
VSV CONTROLLER
HPTACC CONTROLLER
STB CONTROLLER
LPTACC CONTROLLER
FUEL SYSTEM
LVDT LPTACC ACTUATOR
LVDT SBV ACTUATOR
LVDT HPTACC ACTUATOR
A
LVDT VSV ACTUATOR
B
LVDT VSV ACTUATOR
LVDT 2.5 BLEED ACTUATOR
SOL
RVDT
CCC VALVE
HP4
ENGINE AIR SYSTEMS
INHIBITION
ETRAC
TRPU
TLS PROXIMITY SNSR
PROXIMITY SNSR RH SIDE
PROXIMITY SNSR LH SIDE
COWL RESOLVER RH SIDE
COWL RESOLVER LH SIDE
THRUST REVERSER SYSTEM
A
B
OFF LOAD SOL EDP 1
OFF LOAD SOL EDP 2
HYDRAULIC POWER SYSTEM
B
B
SOL
PRESS XDCR
SHUT-OFF REGULATING VALVE
ENGINE ANTI-ICE PROTECTION SYSTEM

EEC COMMAND AND SENSOR INTERFACES

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EIPM ARCHITECTURE & INTERFACE DESCRIPTION (3)

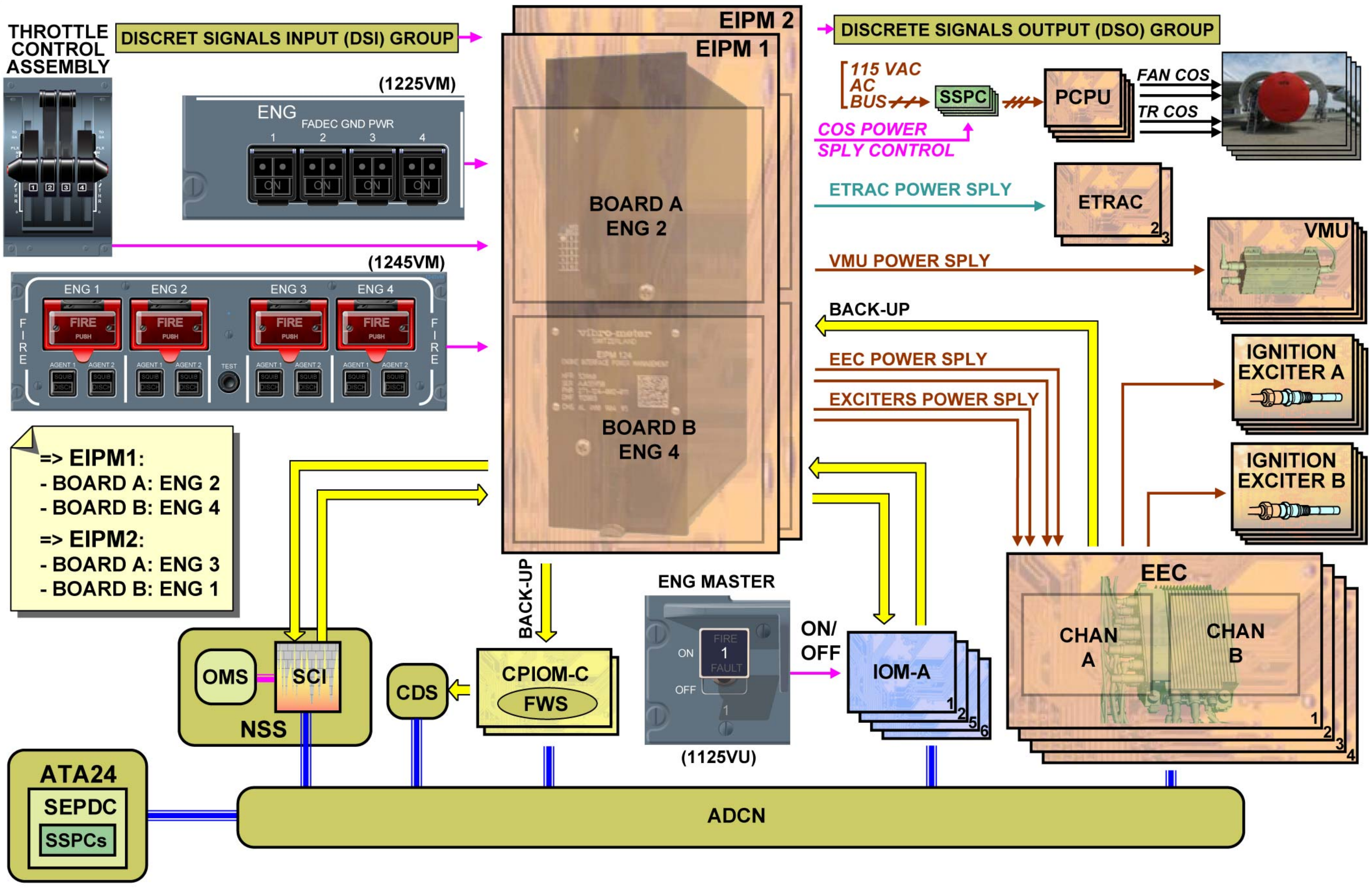
Architecture

There are two Engine Interface Power Management Units (EIPMs) per aircraft, one unit per two engines with separate dedicated boards and one processor per engine.
EIPM1:
- Board A: ENG 2
- Board B: ENG 4

EIPM2:
- Board A: ENG 3
- Board B: ENG 1

The EIPM, installed in the avionics bay, controls and delivers electrical power supply from the aircraft to the engine systems.
The basic function of the EIPM is to control and monitor the electrical power supply to:
- Electronic Engine Control (EEC),
- Cowl Opening System (COS),
- Electronic Thrust Reverser Actuation Controller (ETRAC),
- Vibration Monitoring Unit (VMU),
- Exciters.

From a Discrete Signals Input (DSI) group the EIPM generates for aircraft interface function, Discrete Signals Output (DSO) group.
The EIPM also exchanges data via ARINC 429 with:
- The Onboard Maintenance System (OMS) through the Secure Communication Interface (SCI). The OMS and the SCI are in the Network Server System (NSS),
- The Control and Display System (CDS) via the Core Processing Input Output Modules (CPIOMs) of the Flight Warning System (FWS) as a back-up output,
- The Input Output Module (IOM),
- The EEC Channel A (back-up),
- The Solid State Power Controllers (SSPCs) in the Secondary Electrical Power Distribution Center (SEPDC) via the IOM and the Aircraft Data Communication Network (ADCN).


THROTTLE CONTROL ASSEMBLY
DISCRET SIGNALS INPUT (DSI) GROUP
(1225VM)
ENG
FADEC GND PWR
1
2
3
4
ON
(1245VM)
ENG 1
ENG 2
ENG 3
ENG 4
FIRE
PUSH
AGENT 1
AGENT 2
SQUIB
DISCH
TEST
EIPM 2
EIPM 1
BOARD A ENG 2
BOARD B ENG 4
DISCRETE SIGNALS OUTPUT (DSO) GROUP
115 VAC AC BUS
SSPC
PCPU
FAN COS
TR COS
COS POWER SPLY CONTROL
ETRAC POWER SPLY
ETRAC
2
3
VMU
VMU POWER SPLY
BACK-UP
EEC POWER SPLY
EXCITERS POWER SPLY
IGNITION EXCITER A
IGNITION EXCITER B
EEC
CHAN A
CHAN B
1
2
3
4
ENG MASTER
ON
OFF
FIRE
1
FAULT
(1125VU)
ON/ OFF
IOM-A
5
6
BACK-UP
CPIOM-C
FWS
CDS
OMS
SCI
NSS
ATA24
SEPDC
SSPCs
ADCN

=> EIPM1:
- BOARD A: ENG 2
- BOARD B: ENG 4

=> EIPM2:
- BOARD A: ENG 3
- BOARD B: ENG 1

ARCHITECTURE

EIPM ARCHITECTURE & INTERFACE DESCRIPTION (3)

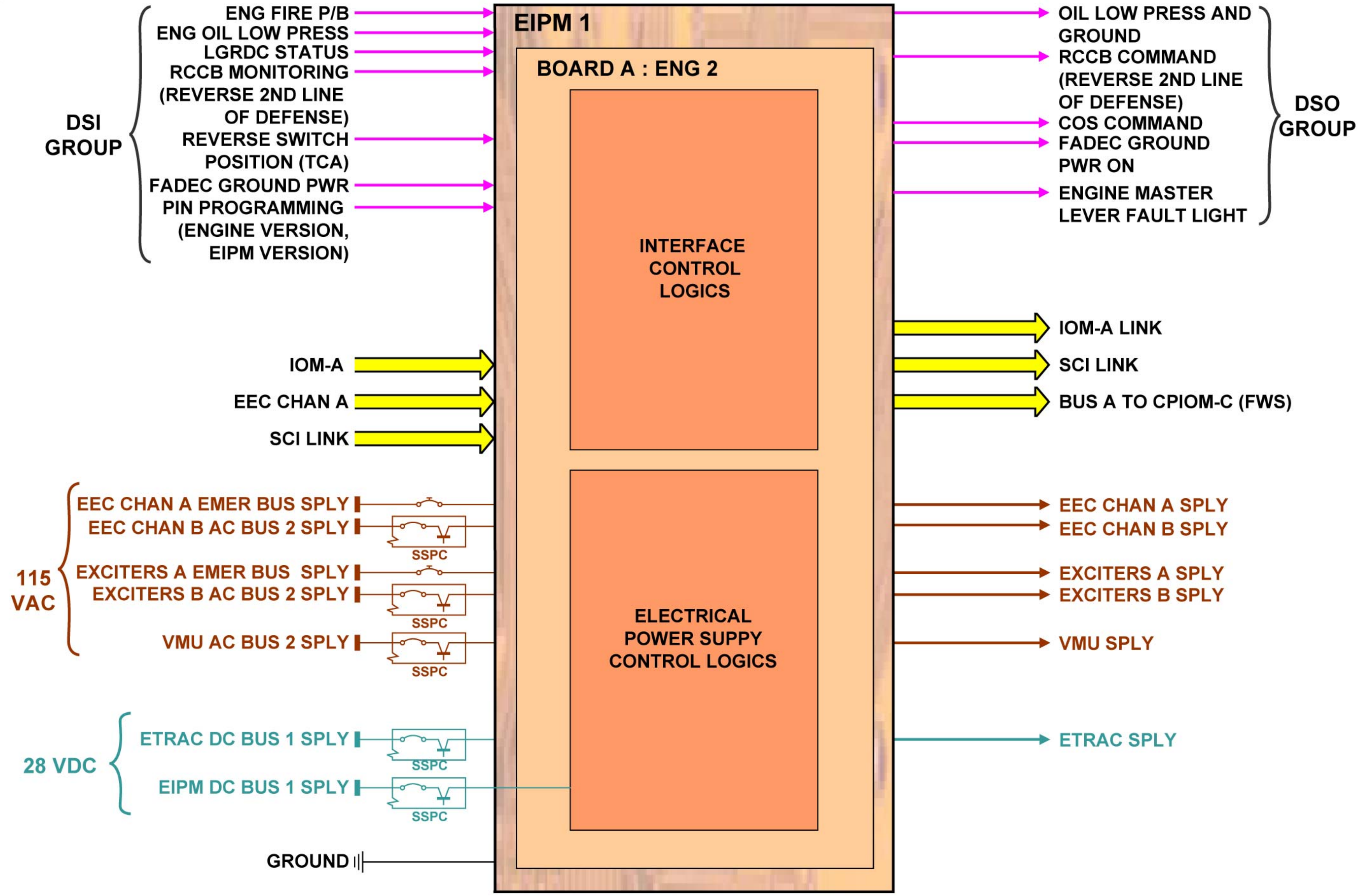
Interfaces

Electrical Power Supply Control Logics

Each electrical power supply normal bus (EEC, Ignition exciters, ETRAC, EIPM) is controlled by SSPCs.
In case of EIPM failure or loss, the EEC channels are fail-safe power supplied.
In the EIPM each power supply is controlled by relays, which are controlled by the electrical power supply control logics.

Interface Control Logics

The EIPM does control and monitoring of the DSI and DSO groups.
The EIPM computes the "oil low press and ground" signal based on the acquisition and the combination of discrete signals from the Landing Gear Remote Data Concentrators (LGRDCs), Oil Low Press switch, and ARINC signal from IOM (SCI, EEC).
The EIPM sends (via discrete signal) the "oil low press and ground" signal to other users (IOM, Cabin Intercommunication Data System (CIDS), Flight Control Data Concentrator (FCDC)).
The EIPM controls the second line of defense of the Thrust Reverser system, according to states of inputs of the LGRDC status, reverse switch position, and ARINC bus. This second line of defense is authorized via discrete output Remote Control Circuit Breaker (RCCB) command.
The EIPM monitors the TR second defense line authorization via the RCCB monitoring input.
The RCCB Command function is only available for engine 2 and engine 3 (inboard engine).
The EIPM controls the opening and closing of the fan Cowl Opening System.
The fan and fan exhaust cowl opening can be done through electrical actuators.
The power supply of Cowls Opening System (COS) is only available when the aircraft is on ground and engine on "oil low press". EIPM also uses ARINC data to manage COS application.
By default, manual cowl opening is inhibited and is carried out by the function of COS.
The power supply to the COS is cut in case of action on the FIRE push button of the related engine.
When the Full Authority Digital Engine Control (FADEC) ground power P/B is activated, the EIPM electrically powers the EEC channels for 10 minutes (maintenance only) if no OMS interactive mode.
If the ENG FIRE P/B SW is activated, the EIPM cuts-off the electrical power supply to EEC channels for isolation function.
The EEC sends the ENG MASTER lever FAULT light to the EIPM.
The EIPM generates a power supply discrete signal to turn the FAULT light on, on the ENG MASTER lever.


DSI GROUP
ENG FIRE P/B
ENG OIL LOW PRESS
LGRDC STATUS
RCCB MONITORING (REVERSE 2ND LINE OF DEFENSE)
REVERSE SWITCH POSITION (TCA)
FADEC GROUND PWR
PIN PROGRAMMING (ENGINE VERSION, EIPM VERSION)
IOM-A
EEC CHAN A
SCI LINK
115 VAC
EEC CHAN A EMER BUS SPLY
EEC CHAN B AC BUS 2 SPLY
SSPC
EXCITERS A EMER BUS SPLY
EXCITERS B AC BUS 2 SPLY
SSPC
VMU AC BUS 2 SPLY
SSPC
28 VDC
ETRAC DC BUS 1 SPLY
SSPC
EIPM DC BUS 1 SPLY
SSPC
GROUND
EIPM 1
BOARD A : ENG 2
INTERFACE CONTROL LOGICS
ELECTRICAL POWER SUPPY CONTROL LOGICS
OIL LOW PRESS AND GROUND
RCCB COMMAND (REVERSE 2ND LINE OF DEFENSE)
COS COMMAND
FADEC GROUND PWR ON
ENGINE MASTER LEVER FAULT LIGHT
DSO GROUP
IOM-A LINK
SCI LINK
BUS A TO CPIOM-C (FWS)
EEC CHAN A SPLY
EEC CHAN B SPLY
EXCITERS A SPLY
EXCITERS B SPLY
VMU SPLY
ETRAC SPLY

INTERFACES - ELECTRICAL POWER SUPPLY CONTROL LOGICS & INTERFACE CONTROL LOGICS

EIPM & FADEC POWER SUPPLY DESCRIPTION (3)

General

The Full Authority Digital Engine Control (FADEC) has two computers:
- Electronic Engine Control (EEC),
- Vibration Monitoring Unit (VMU).

The power supply of the EEC can be processed in two different manners:
- By the airframe power supply (115 VAC) that comes from the Engine Interface Power Management (EIPM),
- By the EEC dedicated alternator, also called Permanent Magnet Alternator (PMA).

EEC is normally powered by its own power supply (PMA), when the engine is running.
VMU is supplied by airframe power supply (115 VAC)

Airframe Power Supply

EIPM is powered by 28 VDC NORMal bus.
The EEC receives power from two airframe 115VAC buses through the EIPM control logic function.
The supply line from the emergency bus is connected to channel A of the EEC and the line from the Airframe Normal bus is connected to channel B of the EEC. In an emergency situation (following loss of all variable frequency generators), only the emergency bus from airframe will operate.
The airframe power supply is available on ground and in flight, and shall be used by the EEC for its ground tests, ground engine starting, and in flight starting when engine speed is below 12.5% N2 in acceleration mode or 10.5% in deceleration mode, or in case of PMA failure.

EEC Dedicated Alternator Power Supply (PMA)

The PMA has a stator and rotor that supply two independent three-phase power windings to the EEC (1 per channel). A mechanical drive from the engine gearbox is used to rotate the PMA rotor. The interface is required to power the EEC in all engine running conditions. When the engine speed is above, 12.5% N2 in acceleration or 10.5% N2 in deceleration, the PMA will deliver the electrical power necessary for the EEC to achieve its functions including in-flight starter assist or wind-milling engine starting.

NOTE: One single phase is dedicated to N2 sensing.

FADEC Power Supply

Aircraft Power-Up

At aircraft Power-up or EIPM initialization, the EEC and the VMU will be powered as detailed below:
Channel A will be powered if the airframe 115 VAC Emergency bus is available,
Channel A & B and the VMU will be powered for 15 minutes if the full airframe electrical network is available.

Engine START Selector

With engine not running:
-When you set the ENG START rotary selector to "CRANK" or "IGN/START" position, power is permanently supplied to the EEC and the VMU,
-When you set the ENG START rotary selector to the "NORM" position the power supply to the EECs and the VMU is cut off.

Engine MASTER Lever

With engine not running:
-Each ENG MASTER lever in the "ON" position supplies power to the related EEC and VMU.
On the ground, airframe 115 VAC will be removed from the EEC and VMU 15 minutes after selection of the ENG MASTER lever from the "ON" to "OFF" position. This will not occur in flight.

Engine FADEC Ground Power

For maintenance operation, with the ENG FADEC GrouND PoWeR P/B selected to the "ON" position and the EEC interactive mode not instigated, airframe 115 VAC will be cut off after 10 minutes.
The airframe 115 VAC power will be cut off immediately by selecting the ENG FADEC GrouND PoWeR P/B to the "OFF" position, or by returning the ENG START rotary selector to the "NORM" position (with the ENG MASTER lever to the "OFF" position).

Engine FIRE Push-Button

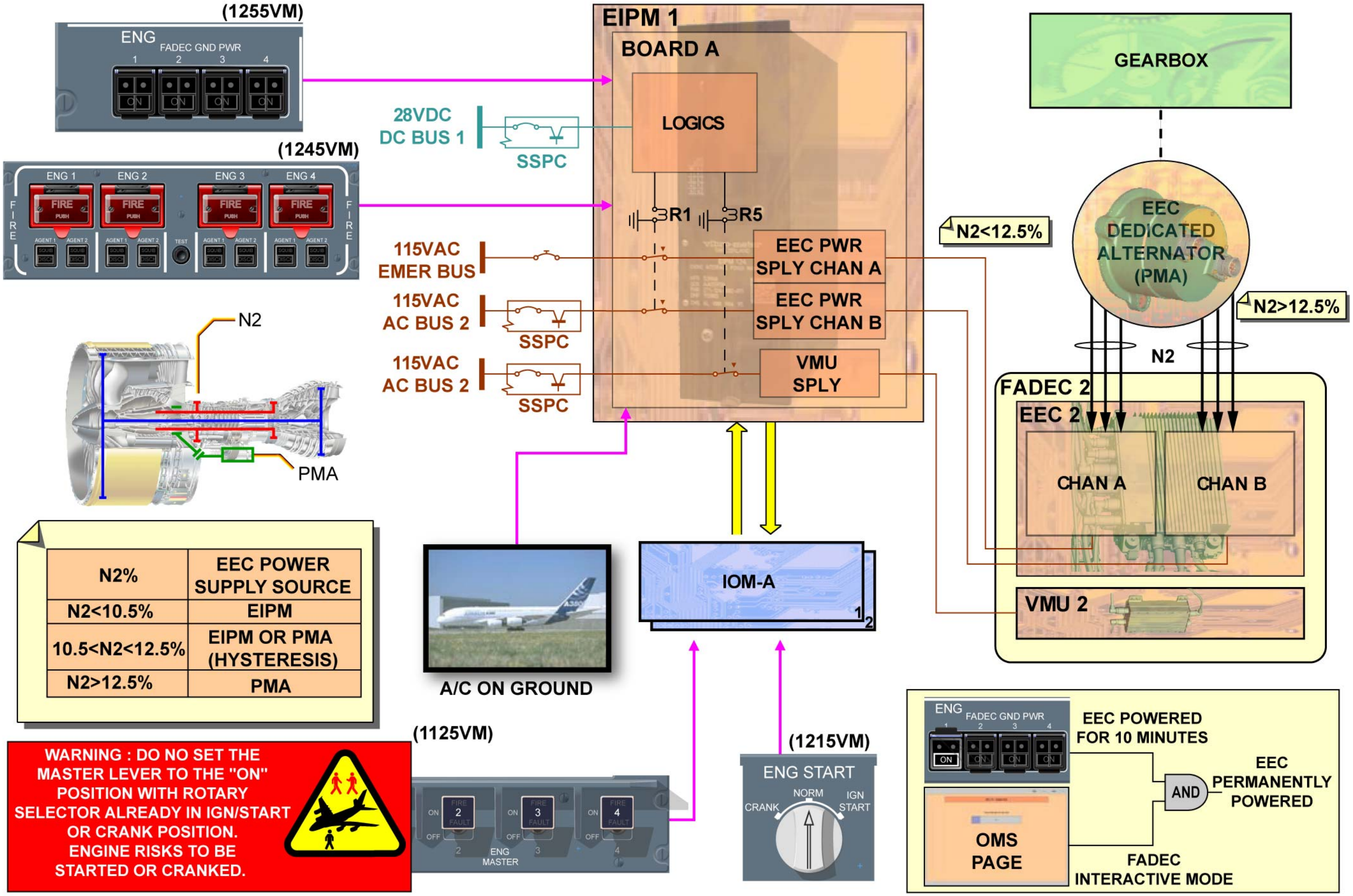
In the case of fire, in flight or on ground, airframe 115 VAC power will be cut off immediately following operation of the ENGine FIRE P/B.

EIPM-Failure

In the event of EIPM failure, airframe 115 VAC power will be permanently available to the EEC and the VMU whenever the airframe electrical network is powered.

EEC Permanent Magnet Alternator (PMA) Failure

If the Permanent Magnet Alternator (PMA) winding for the EEC channel in control becomes defective, there will be an EEC channel change over if the second winding is healthy.
If both alternator windings fail, the EEC will be supplied by the airframe 115 VAC through the EIPM.


(1255VM)
ENG
FADEC GND PWR
1
2
3
4
ON
(1245VM)
ENG 1
ENG 2
ENG 3
ENG 4
FIRE
PUSH
FIRE
AGENT 1
AGENT 2
SQUIB
DISCH
TEST
28VDC
DC BUS 1
SSPC
EIPM 1
BOARD A
LOGICS
R1
R5
115VAC
EMER BUS
115VAC
AC BUS 2
SSPC
115VAC
AC BUS 2
SSPC
EEC PWR
SPLY CHAN A
EEC PWR
SPLY CHAN B
VMU
SPLY
N2<12.5%
GEARBOX
EEC
DEDICATED
ALTERNATOR
(PMA)
N2>12.5%
N2
FADEC 2
EEC 2
CHAN A
CHAN B
VMU 2
N2
PMA
A/C ON GROUND
IOM-A
1
2
(1125VM)
ON
OFF
FIRE
FAULT
2
3
4
ENG
MASTER
(1215VM)
ENG START
CRANK
NORM
IGN
START
ENG
FADEC GND PWR
ON
EEC POWERED
FOR 10 MINUTES
AND
EEC
PERMANENTLY
POWERED
OMS
PAGE
FADEC
INTERACTIVE MODE

N2%	EEC POWER SUPPLY SOURCE
N2<10.5%	EIPM
10.5<N2<12.5%	EIPM OR PMA (HYSTERESIS)
N2>12.5%	PMA

WARNING : DO NO SET THE MASTER LEVER TO THE "ON" POSITION WITH ROTARY SELECTOR ALREADY IN IGN/START OR CRANK POSITION. ENGINE RISKS TO BE STARTED OR CRANKED.

GENERAL & FADEC POWER SUPPLY

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EIPM & FADEC POWER SUPPLY DESCRIPTION (3)

Synthesis table

On the table here after there is a synthesis of the FADEC power supply duration depending on various events.

FADEC POWER SUPPLY DURATION DEPENDING ON THIS VARIOUS EVENTS

ITEM Nº	ON GROUND EVENT	POWER SUPPLY DURATION
1	After A/C Power-up	15 mn
2	FADEC GND PWR P/B set to ON	10 mn
3	FADEC GND PWR P/B set to OFF	cut-off
4	With OMS Interactive Mode (FADEC menu)	permanent
5	After OMS Interactive Mode exit	5 mn
6	ENG MODE selector set to CRANK or IGN	permanent
7	ENG MODE selector set to NORM (Engine not running)	cut-off
8	MASTER lever set to ON	permanent
9	MASTER lever set from ON to OFF	15 mn
10	After engine shutdown or cranking (MASTER Lever OFF)	15 mn
11	ENG FIRE P/B activated	cut-off
12	EIPM Failure	permanent
13	EIPM reset (C/B pulled)	permanent

Note : When the aircraft power is ON, the EIPM is energized.

SYNTHESIS TABLE

FADEC DESCRIPTION (EA) (3)

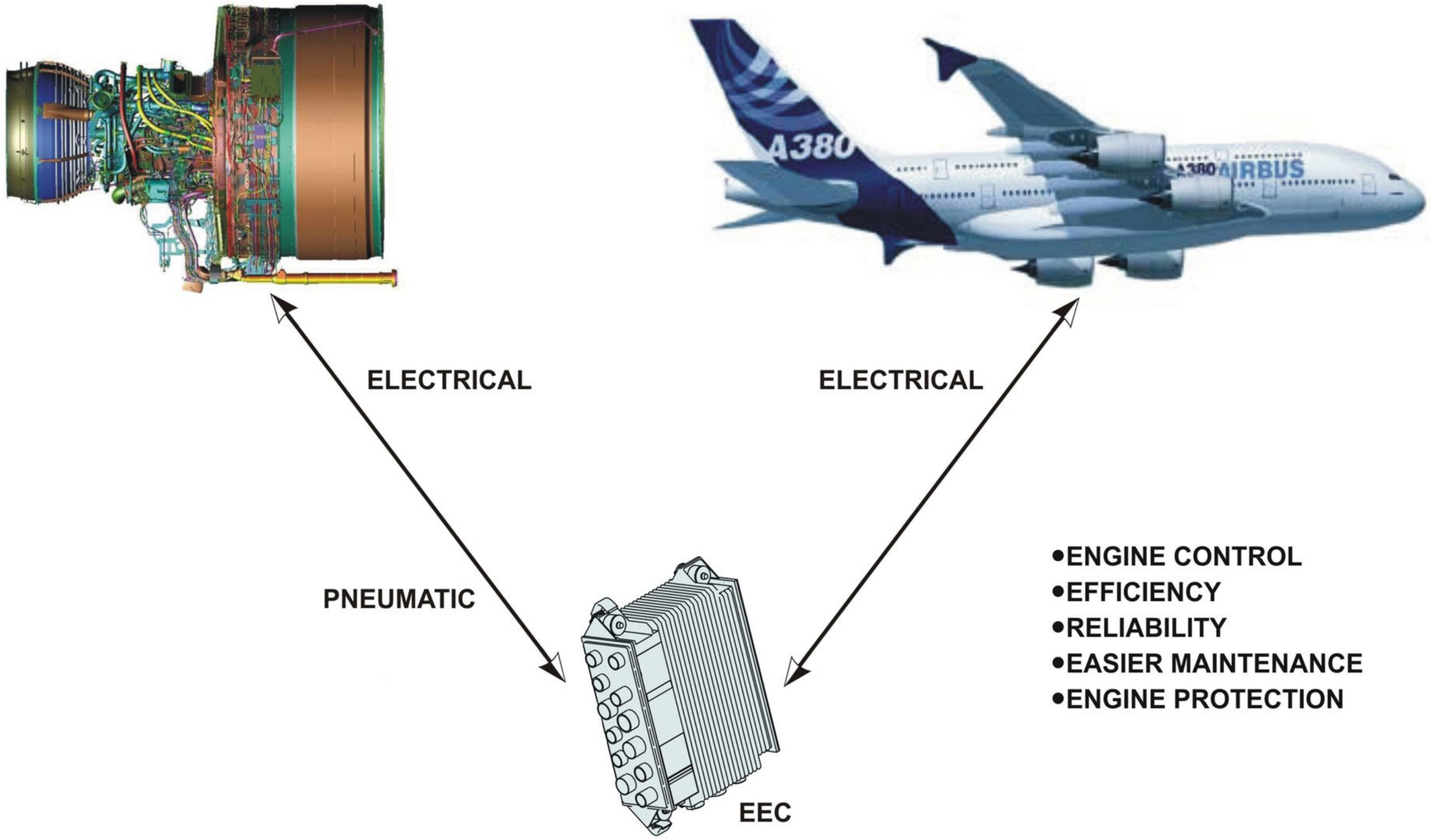
General Overview

Purpose

The Full Authority Digital Engine Control (FADEC) provides steady state and transient control of the engine and it's systems when operated in combination with all applicable airframe supplied subsystems including cockpit controls, aircraft configuration information and aircraft air data.

Description

The EEC interfaces with aircraft and engine control components through electronic and pneumatic subsystems,
It is the primary interface between the engine and the aircraft,
The EEC is used for engine control functions,
The EEC makes the engine:
- Efficient,
- Reliable,
- Easier to maintain.



- •ENGINE CONTROL
- •EFFICIENCY
- •RELIABILITY
- •EASIER MAINTENANCE
- •ENGINE PROTECTION

CTC70112.20061212

GENERAL OVERVIEW - PURPOSE & DESCRIPTION

FADEC DESCRIPTION (EA) (3)

Overview

Purpose

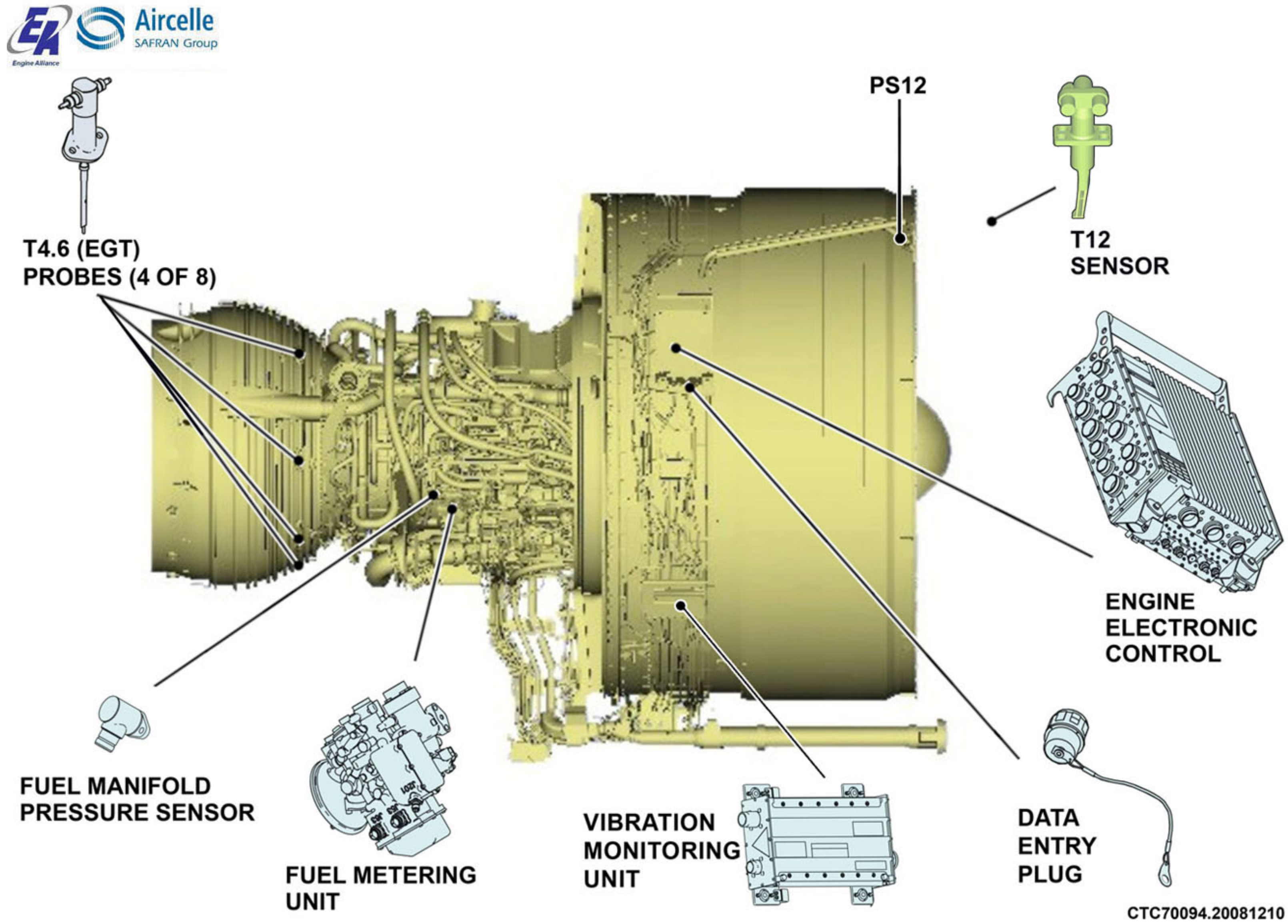
The FADEC system provides complete thrust control, fault monitoring and accommodation for the engine systems.

Components Engine Right Side

Electronic Engine Control (EEC):
- Installed on the fan case at 2 o'clock.
Data Entry Plug (DEP):
- Installed on the bottom of the EEC (channel A side) P11 connector.
Fan case wiring harnesses (16)
- Located around the fan case.
Engine core wiring harnesses (14)
- Located along the core of the engine from the fan hub frame to the exhaust case.
T4.6 (EGT) probes (4 of 8):
- Located in the LPT case second stage vane assembly at 1, 3, 5, and 6 o'clock.
PS12 sensor:
- Attached to the fan case at 1 o'clock.
T12 temperature sensor:
- Attached to the air intake cowl at 1 o'clock.
Fuel manifold pressure sensor:
- Attached to the FMU at 3:30 o'clock.
Fuel Metering Unit (FMU):
- Attached to the main gearbox at 4 o'clock.
Vibration Monitoring Unit (VMU):
-Installed on the fan case at 4:30.

LRUs

Electronic engine control,
Data entry plug,
Fan case wiring harnesses (16),
Engine core wiring harnesses (14),
Fuel metering unit,
T4.6 (EGT) probes,
T12 probe,
Fuel manifold pressure sensor,
Vibration Monitoring Unit.


Engine Alliance
Aircelle
SAFRAN Group
PS12
T12
SENSOR
T4.6 (EGT)
PROBES (4 OF 8)
ENGINE
ELECTRONIC
CONTROL
FUEL MANIFOLD
PRESSURE SENSOR
FUEL METERING
UNIT
VIBRATION
MONITORING
UNIT
DATA
ENTRY
PLUG
CTC70094.20081210

OVERVIEW - PURPOSE ... LRUS

FADEC DESCRIPTION (EA) (3)

Overview (continued)

Components Engine Left Side

Permanent Magnet Alternator (PMA):
- Installed on the front left side of the main gearbox at 7 o'clock.

Servo Valve Assembly (SVA):
- Located on the front high compressor case at 12 o'clock.

T4.6 (EGT) probes (4 of 8):
- Located in the LPT case second stage vane assembly at, 7, 8, 9, and 11 o'clock.

P/T2.5 pressure/temperature sensor:
- Attached to the fan hub frame at 8 o'clock.

T3 temperature sensor:
- Attached to the combustion case at 8 o'clock.

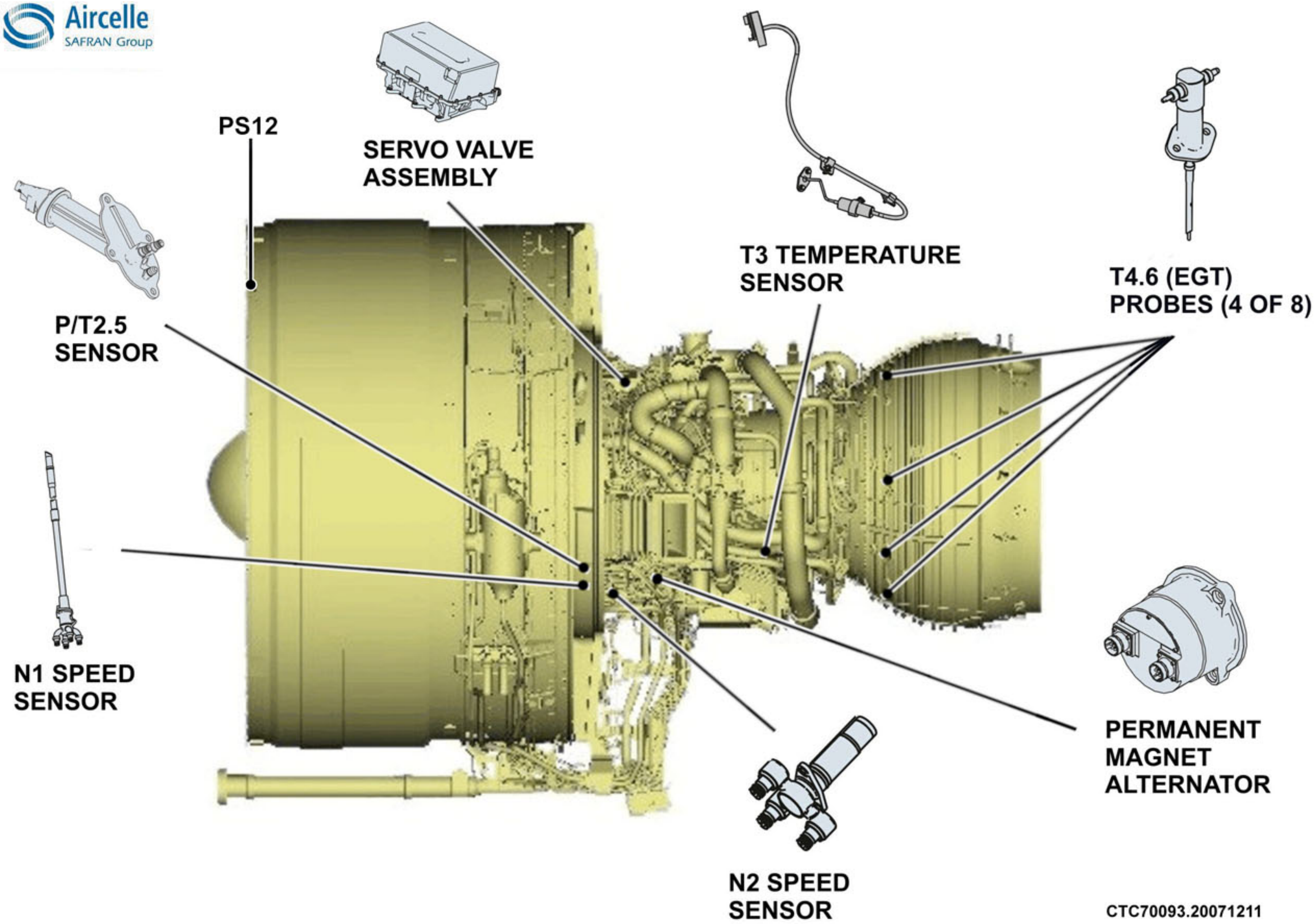
N1 speed sensor:
- Attached to the fan hub frame at 7 o'clock.

N2 speed sensor:
- Attached to the angle gearbox at 6:30 o'clock.

PS12 sensor:
- Attached to fan case at 11 o'clock.

LRUs

Permanent magnet alternator,
Servo valve assembly,
T4.6 (EGT) probes,
P/T2.5 sensor,
T3 sensor,
N1 speed sensor,
N2 sensor.


PS12
SERVO VALVE ASSEMBLY
T3 TEMPERATURE SENSOR
T4.6 (EGT) PROBES (4 OF 8)
P/T2.5 SENSOR
N1 SPEED SENSOR
PERMANENT MAGNET ALTERNATOR
N2 SPEED SENSOR
CTC70093.20071211

OVERVIEW - COMPONENTS ENGINE LEFT SIDE & LRUS

LB408521 - L5CT0T0 - LM7E92000000001

FADEC DESCRIPTION (EA) (3)

Electronic Engine Control

Purpose

The Electronic Engine Control (EEC) provides control, and performs maintenance tests and fault monitoring of the engine valves, actuators, solenoids, data buses, power supplies, sensors and probes for the engine.

Description and Operation

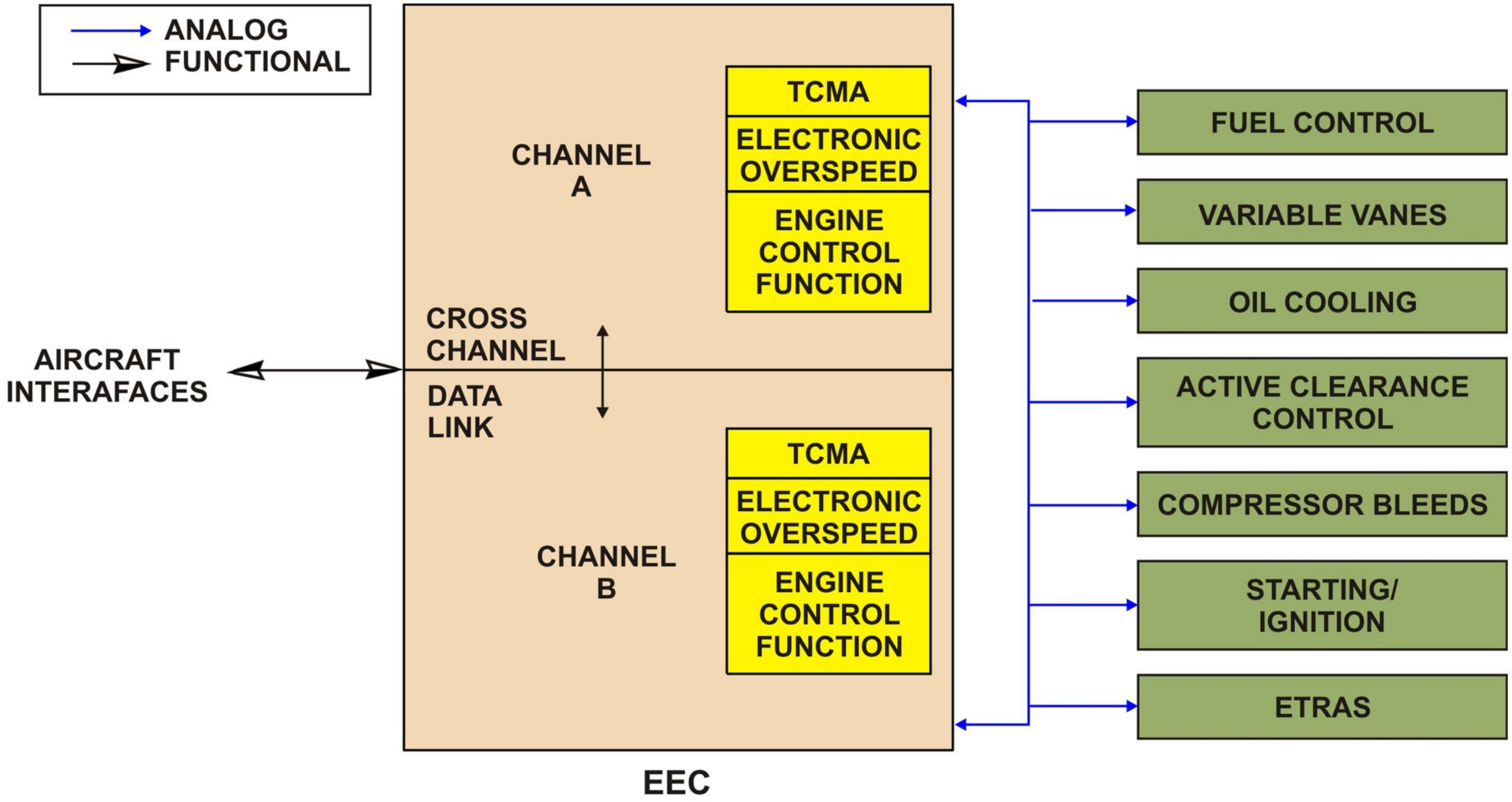
The EEC controls the engine in response to thrust command inputs from the aircraft, and provides information to the aircraft for cockpit indication, maintenance reporting, and engine conditioning monitoring. It is the primary interface between the engine and the aircraft, and operates with aircraft systems to do fuel flow, engine airflow and engine bleeds control.
The EEC is used for basic engine control functions:
- Starting,
- Idle,
- Acceleration,
- Deceleration,
- Stability,
- Thrust Control,
- Intake Anti-ice,
- Thrust Reverse.

The EEC controls the operation, performance and efficiency of the engine by controlling the:
- Fuel metering unit,
- Variable vanes,
- Engine oil cooling,
- Active Clearance Control (ACC),
- Compressor bleeds,
- Starting and Ignition.

The EEC provides operational reliability of the engine by using:
- Two channel control that provides:
. Automatic N1 control,
. Automatic agreement between the throttle lever position and engine thrust.
- Automatic fault detection,
- Automatic fault compensation,
- Redundant inputs and outputs.

The EEC makes engine maintenance easier by doing:
- Self-tests,
- Fault isolation,
- Engine Condition Monitoring (ECM).

The EEC provides engine protection for:
- Overspeed:
. The electronic overspeed system (independent circuits for N1 and N2).
- Over thrust:
. Thrust Control Malfunction Accommodation (TCMA).


ANALOG
FUNCTIONAL
CHANNEL A
TCMA
ELECTRONIC OVERSPEED
ENGINE CONTROL FUNCTION
CROSS CHANNEL DATA LINK
AIRCRAFT INTERAFACES
CHANNEL B
TCMA
ELECTRONIC OVERSPEED
ENGINE CONTROL FUNCTION
EEC
FUEL CONTROL
VARIABLE VANES
OIL COOLING
ACTIVE CLEARANCE CONTROL
COMPRESSOR BLEEDS
STARTING/ IGNITION
ETRAS

CTC70126.20070109

ELECTRONIC ENGINE CONTROL - PURPOSE & DESCRIPTION AND OPERATION

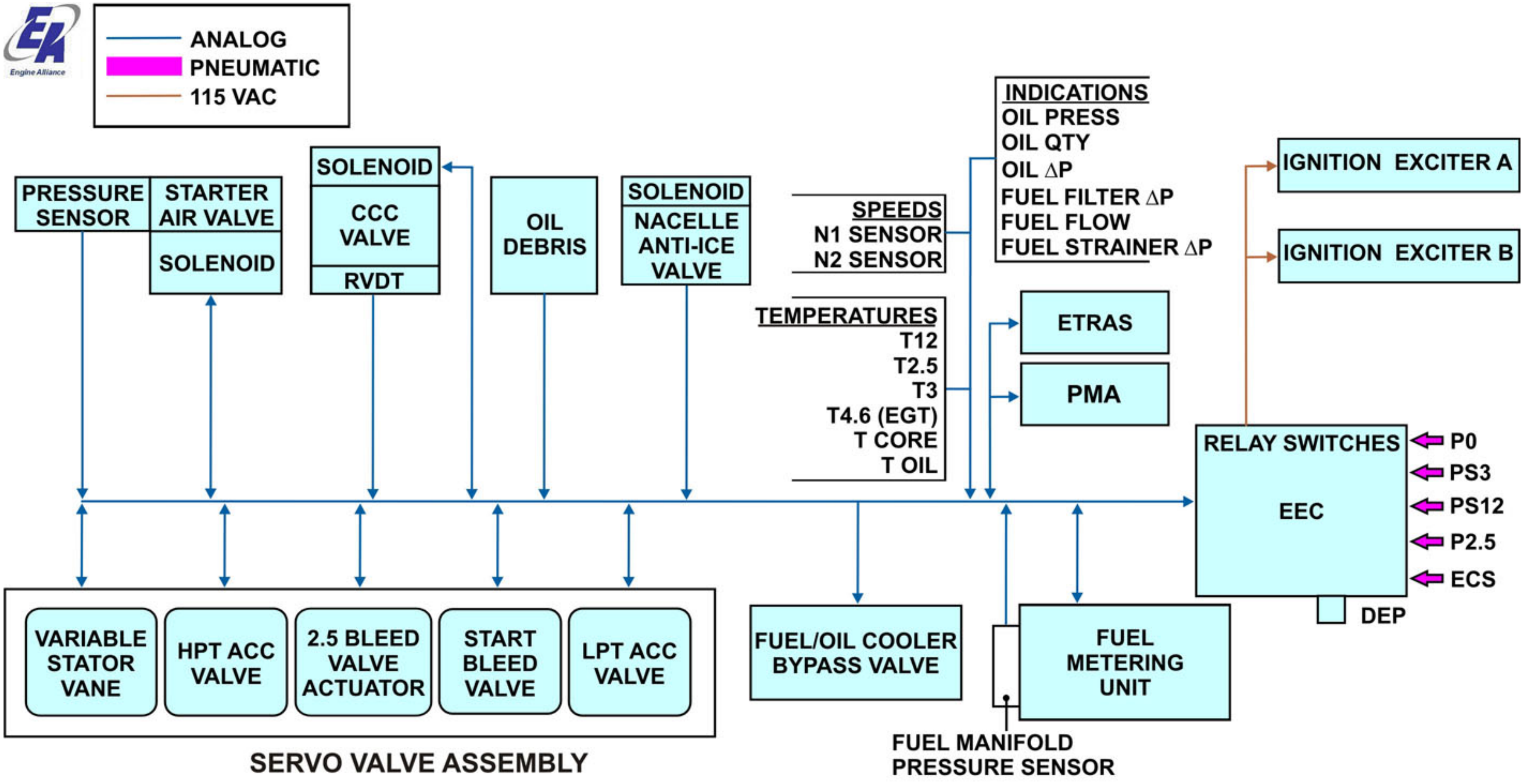
FADEC DESCRIPTION (EA) (3)

Electronic Engine Control (continued)

Description and Operation (Continued)

The EEC is a dual channel, fault tolerant, digital unit with cross channel communication.
Both EEC channels are identical, and both are fully capable of operating the engine systems.
Only one channel at a time will operate the engine valves, actuators and solenoids. This channel is called the channel in control or the active channel; the other channel will be in standby.
The EEC will change the channel in control every other flight, as long as they are equally healthy.
The only exception to this channel active/standby architecture is the Electronic Overspeed System (EOS) protection circuit and the Thrust Control Malfunction Accommodation (TCMA).
The EEC receives electrical power from the aircraft or the permanent magnet alternator (PMA), and information from the following engine mounted components:

- Data entry plug,
- Permanent magnet alternator,
- N1 speed sensor,
- N2 speed sensor,
- T3 temperature sensor,
- T12 temperature sensor,
- PT2.5 pressure/temperature sensor,
- T4.6 (EGT) probes and harnesses,
- 2.5 bleed actuator,
- PS12,
- PS3,
- P0,
- ECS,
- Servo valve assembly,
- High pressure turbine active clearance control (HPT ACC),
- Low pressure turbine active clearance control (LPT ACC),
- Engine oil pressure sensor,
- Starter Air Valve (SAV),
- Starter air valve delta pressure sensor,
- Variable Stator Vane (VSV) actuator,
- Core Compartment Cooling (CCC) valve,
- Fuel manifold pressure sensor,
- Oil Debris Monitoring (ODM) system,
- Oil Temperature Sensor (OTS),
- Wiring harnesses,
- Fuel flow transmitter,
- Core compartment temperature sensor,
- Oil filter delta pressure sensor,
- Fuel filter delta pressure sensor,
- Fuel Metering Unit (FMU),
- Engine oil level sensor,
- Vibration Monitoring Unit (VMU).
- ETRAS


ANALOG
PNEUMATIC
115 VAC
PRESSURE SENSOR
STARTER AIR VALVE
SOLENOID
SOLENOID
CCC VALVE
RVDT
OIL DEBRIS
SOLENOID
NACELLE ANTI-ICE VALVE
SPEEDS
N1 SENSOR
N2 SENSOR
TEMPERATURES
T12
T2.5
T3
T4.6 (EGT)
T CORE
T OIL
INDICATIONS
OIL PRESS
OIL QTY
OIL ΔP
FUEL FILTER ΔP
FUEL FLOW
FUEL STRAINER ΔP
ETRAS
PMA
IGNITION EXCITER A
IGNITION EXCITER B
RELAY SWITCHES
EEC
P0
PS3
PS12
P2.5
ECS
DEP
VARIABLE STATOR VANE
HPT ACC VALVE
2.5 BLEED VALVE ACTUATOR
START BLEED VALVE
LPT ACC VALVE
SERVO VALVE ASSEMBLY
FUEL/OIL COOLER BYPASS VALVE
FUEL METERING UNIT
FUEL MANIFOLD PRESSURE SENSOR

CTC70111.20081008

ELECTRONIC ENGINE CONTROL - DESCRIPTION AND OPERATION (CONTINUED)

FADEC DESCRIPTION (EA) (3)

Data Entry Plug

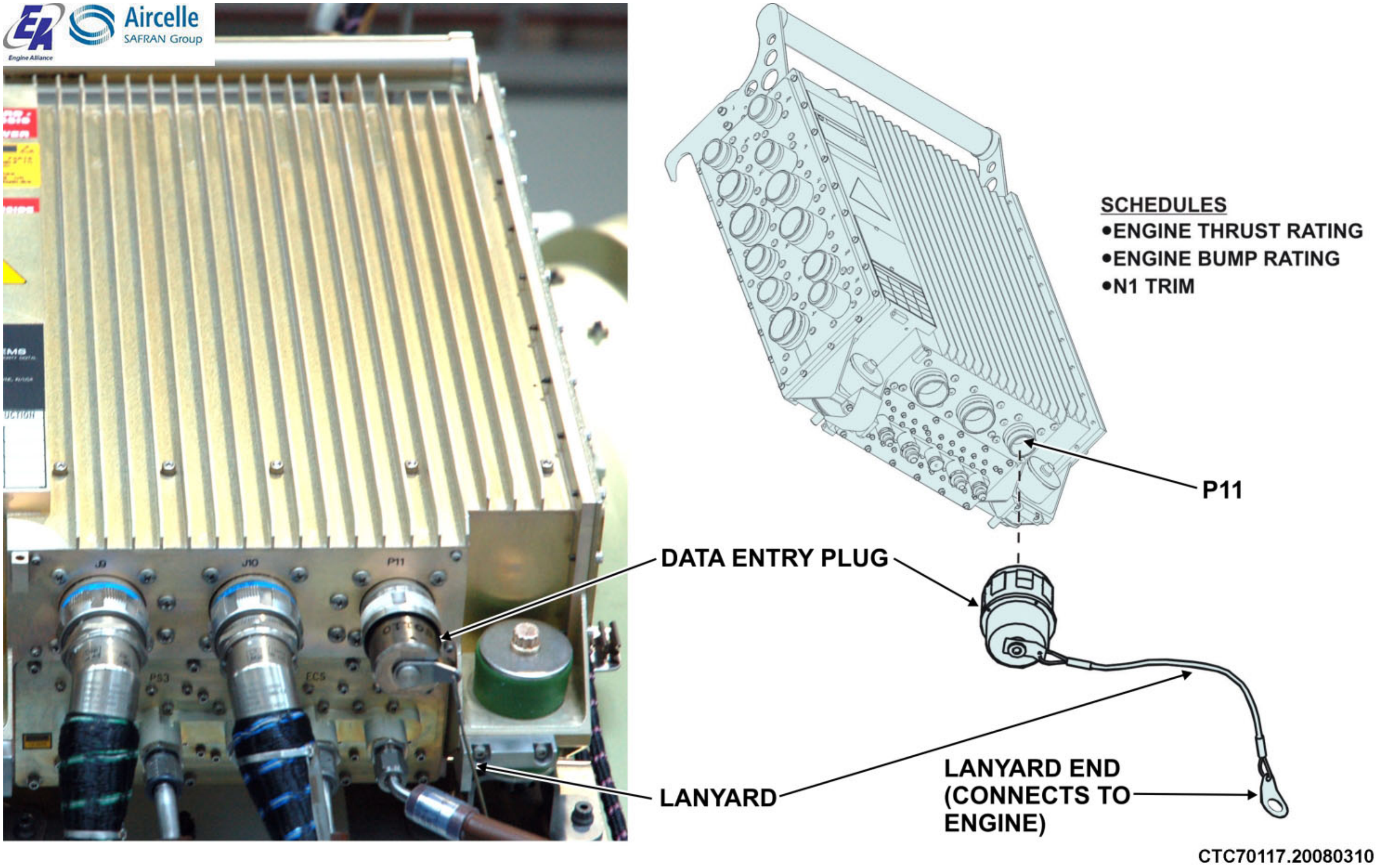
Purpose

The Data Entry Plug (DEP) selects the applicable schedules in the electronic engine control for:
- Engine thrust rating,
- Engine bump rating,
- N1 trim.

Description and Operation

The data entry plug consists of fixed settings using fusible links and user programmable settings using push-pull pins.
The EEC reads the data entry plug during initialization at each ground power up.
If the read-operation is valid, the data is stored in the EEC's non-volatile memory.
If there is a read failure and the non-volatile memory is not valid, the EEC selects the default values:
- Highest rating available,
- No bump,
- No N1 trim.

The engine bump settings provide additional thrust above max takeoff thrust.
The N1 trim consist of a trim to the N1 command to supply the specified thrust and a trim to the selected N1 used for cockpit display so that the displayed N1 for the four engines are consistent when they are commanded to the same rated power setting (N1 Actual Trim).
In the event of a read failure of the data entry plug, the validation status is set to invalid, and a no-dispatch fault will be set.
The data entry plug is physically attached by a lanyard to the fan case, and remains with the engine if the EEC is replaced.


J9
J10
P11
PS3
ECS
SCHEDULES
•ENGINE THRUST RATING
•ENGINE BUMP RATING
•N1 TRIM
P11
DATA ENTRY PLUG
LANYARD
LANYARD END (CONNECTS TO ENGINE)
CTC70117.20080310

DATA ENTRY PLUG - PURPOSE & DESCRIPTION AND OPERATION

FADEC DESCRIPTION (EA) (3)

Engine Limits Protection

Purpose

The FADEC system incorporates hardware and software limits to prevent overboost and overspeed of the engine.

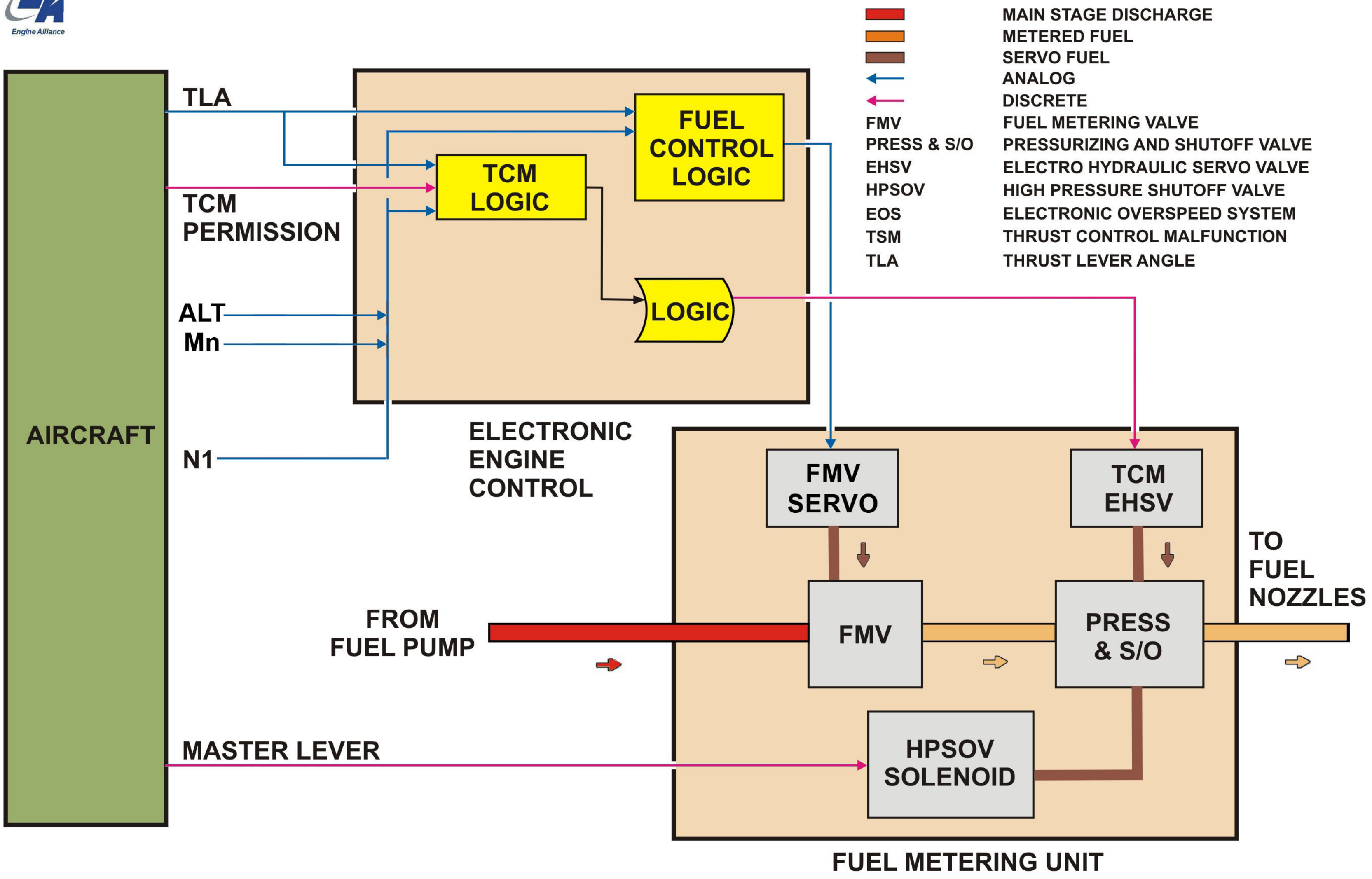
Description

Limit protection is provided for N1, N2, fuel flow, and combustor pressure.
In addition, during sub-idle operation on the ground only, the FADEC system will prevent the engine from exceeding starting EGT limits.
The engine limit and protection system has two subsystems:
- Thrust Control Malfunction Accommodation (TCMA),
- Electronic Overspeed System (EOS).

Thrust Control Malfunction Accommodation

Purpose:
- TCMA is a function designed to automatically shutoff fuel to the engine, via the fuel metering unit's high pressure shutoff valve, whenever an over thrust is detected. The TCMA is inactive for altitudes greater than 15000 feet or aircraft mach numbers greater than 0.40

Description and operation:
- The system operates with dual wound torque motors giving each EEC channel the ability to react to an over thrust condition. N1 is the thrust monitoring parameter.
- The TCMA logic is operational in both active and standby channels.
- Either channel can initiate a fuel reduction (cutback function) or a shutdown, if it has the adequate health and all the conditions are met.
- TCMA detection logic compares actual N1 to an N1 trigger threshold. The TCMA threshold uses the N1 command derived from power management schedules and TRA with additional margin to allow for transient overshoots and other regulators.
- In addition, there is maximum limit of 110% N1.
- N1, mach number, and altitude are essential input parameters; the loss of all valid data for any of these inputs will inhibit TCMA and set a Class 1 fault, NO GO message.
- Both, cut back and shut down TCMA functions are tested during ground start.
- There are no TCMA tests while the engine is running.


TLA
TCM PERMISSION
ALT
Mn
N1
MASTER LEVER
AIRCRAFT
TCM LOGIC
FUEL CONTROL LOGIC
LOGIC
ELECTRONIC ENGINE CONTROL
FMV SERVO
TCM EHSV
FMV
PRESS & S/O
HPSOV SOLENOID
FROM FUEL PUMP
TO FUEL NOZZLES
FUEL METERING UNIT

🟥	MAIN STAGE DISCHARGE
🟧	METERED FUEL
🟫	SERVO FUEL
←	ANALOG
←	DISCRETE
FMV	FUEL METERING VALVE
PRESS & S/O	PRESSURIZING AND SHUTOFF VALVE
EHSV	ELECTRO HYDRAULIC SERVO VALVE
HPSOV	HIGH PRESSURE SHUTOFF VALVE
EOS	ELECTRONIC OVERSPEED SYSTEM
TSM	THRUST CONTROL MALFUNCTION
TLA	THRUST LEVER ANGLE

CTC70114.20081211_a

ENGINE LIMITS PROTECTION - PURPOSE & DESCRIPTION

LB408521 - L5CT0T0 - LM7E92000000001

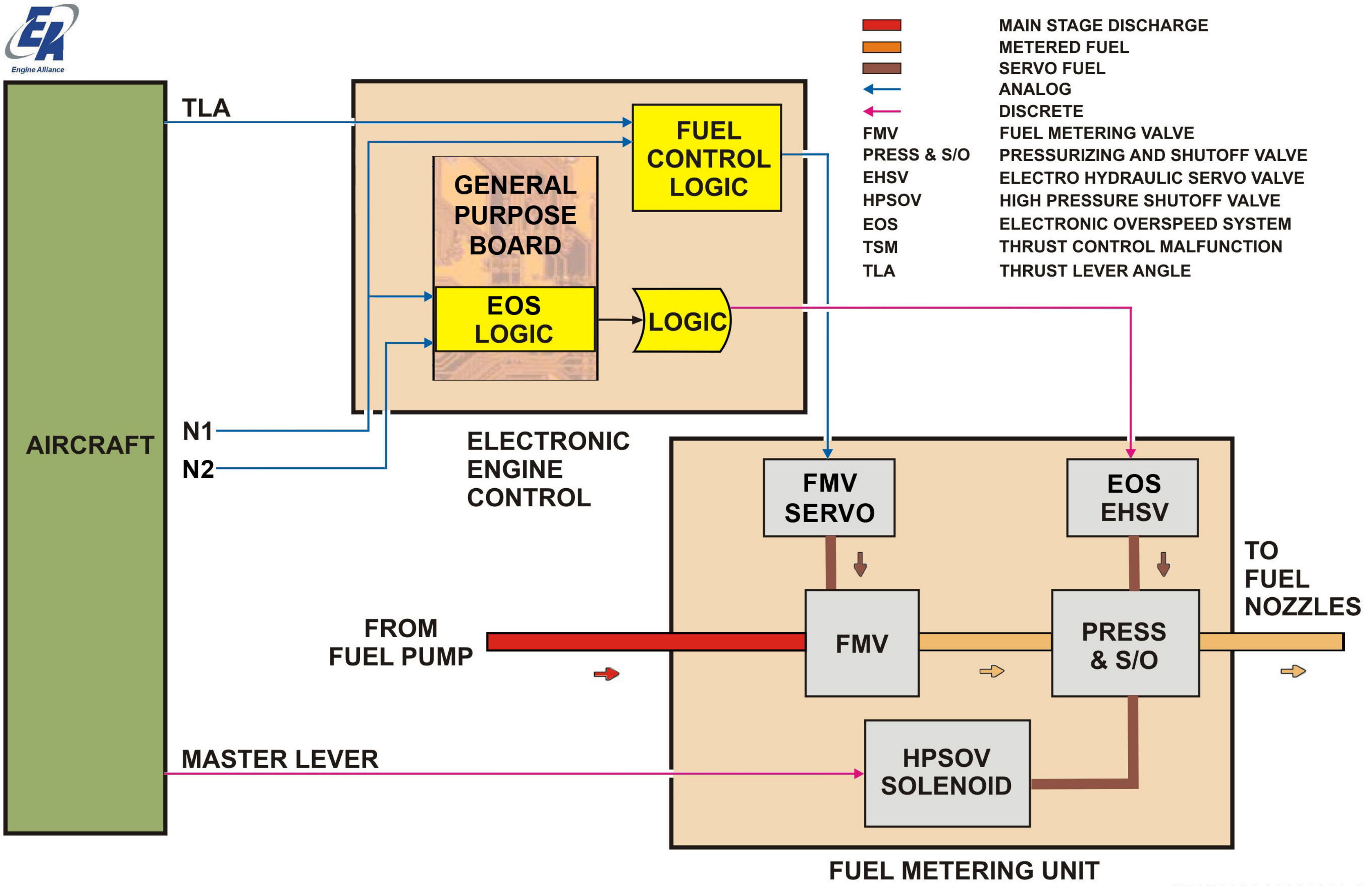
FADEC DESCRIPTION (EA) (3)

Engine Limits Protection (continued)

Description (Continued)

Electronic Overspeed System
Purpose:
- The Electronic Overspeed System (EOS) is a function designed to automatically shutoff fuel to the engine, via the fuel metering unit's high pressure shutoff valve, whenever an overspeed is detected.

Description and operation:
- The EOS is self-contained on a separate circuit card, called the General Purpose Board that contains the main processing functions.
- The EOS receives power from a common power source, various analogue and discrete signals, and a digital bus from the main board.
- Once activated, the system remains in shut off until the metering valve closes. Opening the metering valve allows the high pressure shutoff valve to re-open if the master lever is not in the off position.
- The EOS has a Built In Test (BITE) feature, which is initiated during engine start, as the test requires minimum N1 and N2 speeds for successful execution
- Loss of EOS in one channel results in a maintenance message, but no dispatch limitation.
- Loss of EOS in both channels will result in a no dispatch condition.


Engine Alliance
AIRCRAFT
TLA
N1
N2
MASTER LEVER
GENERAL PURPOSE BOARD
FUEL CONTROL LOGIC
EOS LOGIC
LOGIC
ELECTRONIC ENGINE CONTROL
FMV SERVO
EOS EHSV
FROM FUEL PUMP
FMV
PRESS & S/O
TO FUEL NOZZLES
HPSOV SOLENOID
FUEL METERING UNIT

🟥	MAIN STAGE DISCHARGE
🟧	METERED FUEL
🟫	SERVO FUEL
←	ANALOG
←	DISCRETE
FMV	FUEL METERING VALVE
PRESS & S/O	PRESSURIZING AND SHUTOFF VALVE
EHSV	ELECTRO HYDRAULIC SERVO VALVE
HPSOV	HIGH PRESSURE SHUTOFF VALVE
EOS	ELECTRONIC OVERSPEED SYSTEM
TSM	THRUST CONTROL MALFUNCTION
TLA	THRUST LEVER ANGLE

CTC70114.20081211_b

ENGINE LIMITS PROTECTION - DESCRIPTION (CONTINUED)

FADEC DESCRIPTION (EA) (3)

Vibration Monitoring

Purpose

The Vibration Monitoring System (VMS) provides engine vibration levels to the cockpit, and is capable of computing fan and low pressure turbine balancing solutions.

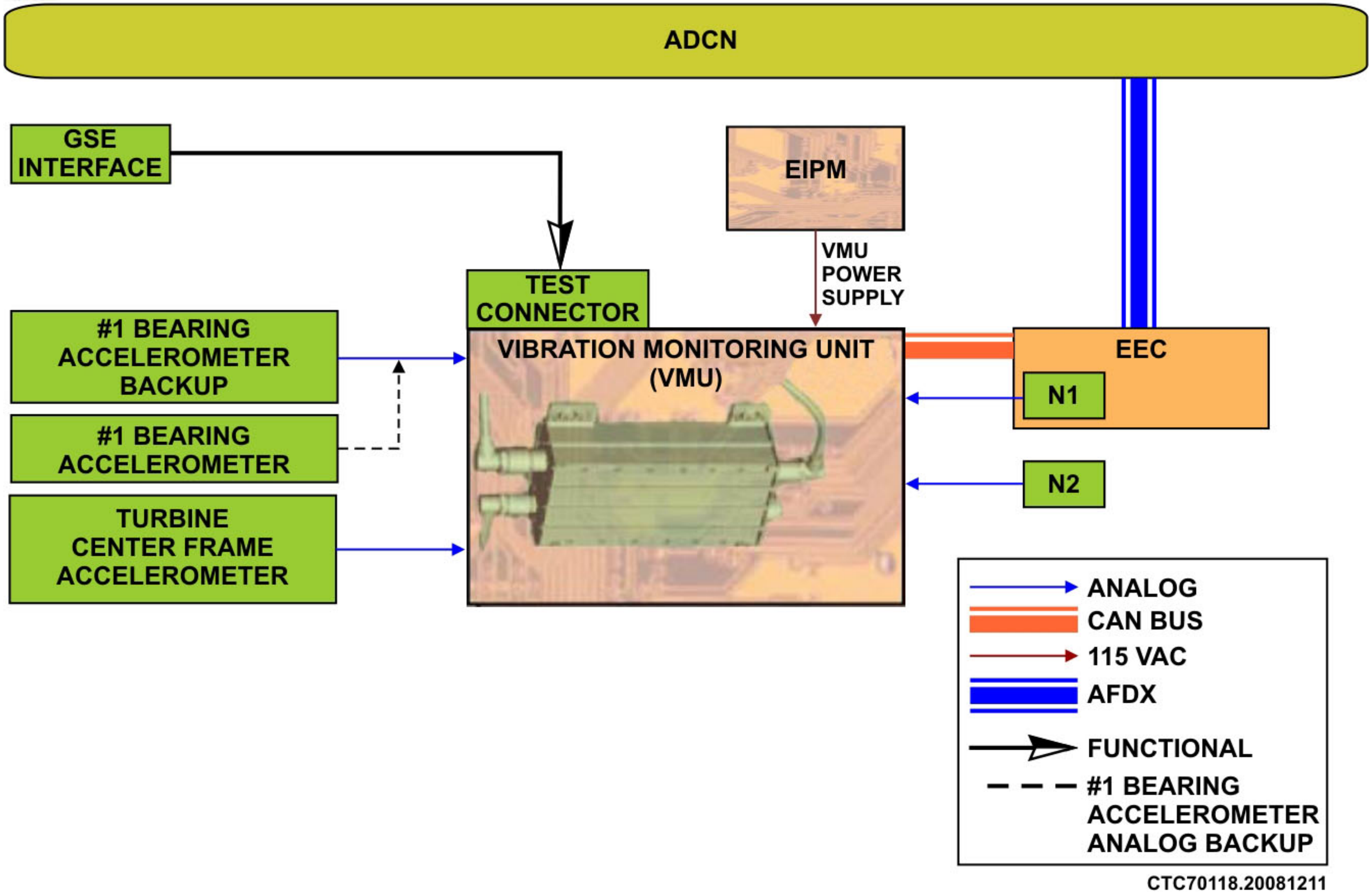
Description

The VMS consists of:
- The Vibration Monitoring Unit (VMU),
- The No. 1 bearing and No. 1 bearing alternate accelerometers,
- The turbine center frame accelerometer,
- The N1 speed signal from the EEC,
- The N2 speed signal from the N2 speed sensor,
- Associated cables and connectors,
- The CAN Bus interface to the EEC.

Vibration Monitoring Unit

Description and operation:
- The Vibration Monitoring Unit (VMU) is mounted on the engine fan case at 4 o'clock.
- It receives the engine's ID from the EEC.
- It interfaces with the aircraft via the ADCN bus through the EEC, and has a dedicated power source from aircraft.
- The VMU receives signals from the engine-mounted accelerometers and speed sensors, and computes the tracked vibration amplitudes for each accelerometer in relation to the speed sensors.
- The results are scaled to aircraft units, and are transmitted to the cockpit for continuous indication using the CAN bus via the EEC.
- It performs high vibration detection, and transmits vibration alerts to the cockpit via the EEC.
- It calculates and stores trim balance coefficients for the No. 1 bearing, backup, and turbine center frame accelerometers with respect to fan and low pressure turbine unbalance.
- It stores the current balance weight configuration for the fan and low pressure turbine.
- The VMU has five modes of operation:
  . Power off,
  . Power on initialization,
  . Normal mode,
  . Interactive mode,
  . Reprogramming mode.

The VMU has a test connector interface for ground support equipment.


ADCN
GSE INTERFACE
EIPM
VMU POWER SUPPLY
TEST CONNECTOR
#1 BEARING ACCELEROMETER BACKUP
#1 BEARING ACCELEROMETER
TURBINE CENTER FRAME ACCELEROMETER
VIBRATION MONITORING UNIT (VMU)
EEC
N1
N2
ANALOG
CAN BUS
115 VAC
AFDX
FUNCTIONAL
#1 BEARING ACCELEROMETER ANALOG BACKUP
CTC70118.20081211

VIBRATION MONITORING - PURPOSE ... VIBRATION MONITORING UNIT

FADEC MAINTENANCE (3)

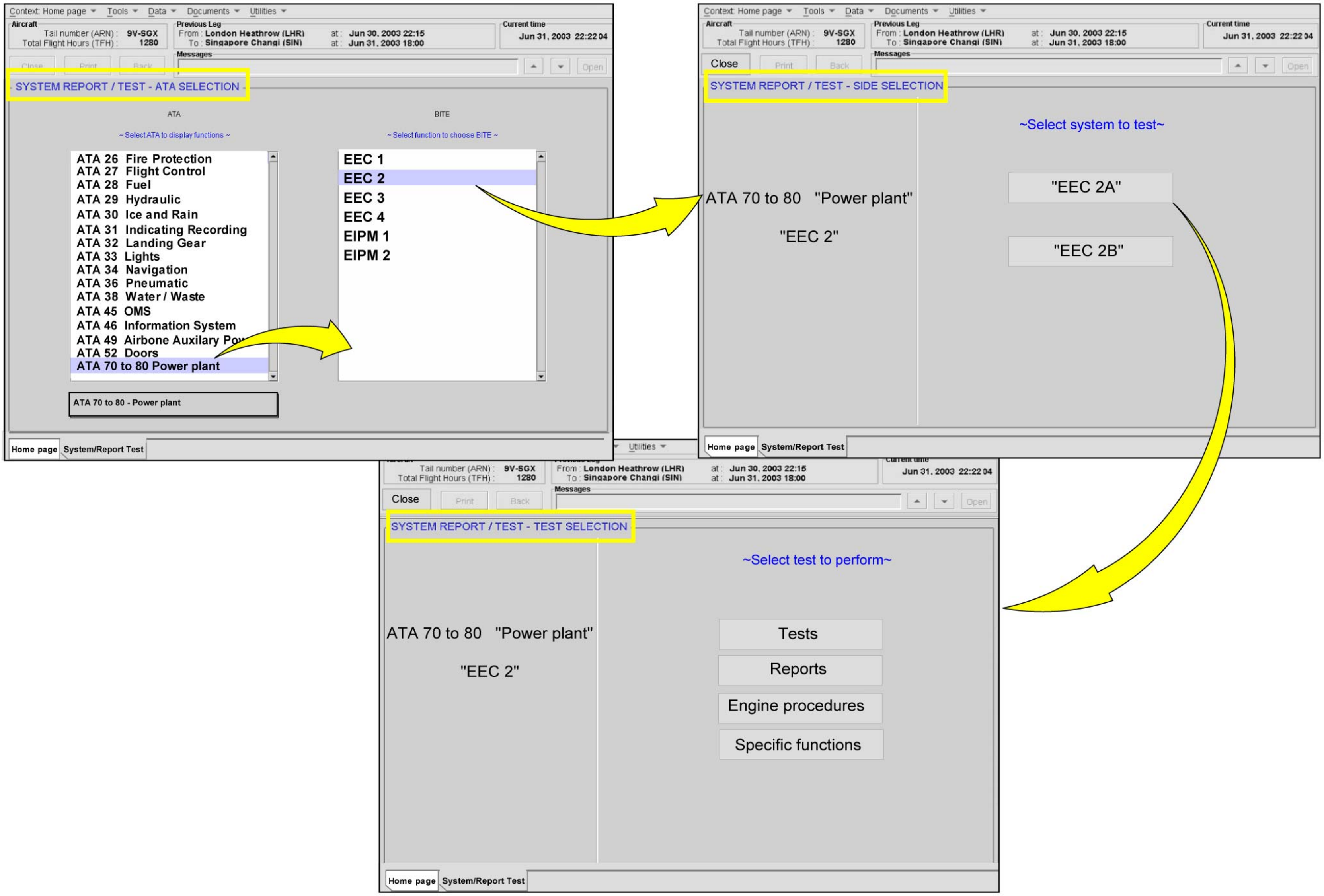
Tests

The Onboard Maintenance System (OMS) is used for the test of two main computers of the power plant system:
- EEC (Electronic Engine Control)
- EIPM (Engine Interface Power Management)

These tests are launched from the OMS Human-Machine Interface (HMI) using the Onboard Maintenance Terminal (OMT), Onboard Information Terminal (OIT) or Portable Multipurpose Access Terminal (PMAT).

EEC

To reach the "TEST SELECTION" page, you must select the ATA 70 to 80 "Power Plant" and the system to test in the "ATA SELECTION" page (EEC 1 to EEC 4, EIPM 1 or EIPM 2). Then you select the channel in the "SIDE SELECTION" ("EEC 2A or EEC 2B").
The EEC gives the following interactive tests, reports, engine procedures, and specific functions:



Aircraft
Tail number (ARN) : 9V-SGX
Total Flight Hours (TFH) : 1280

Previous Leg
From : London Heathrow (LHR) at : Jun 30, 2003 22:15
To : Singapore Changi (SIN) at : Jun 31, 2003 18:00

Current time
Jun 31, 2003 22:22 04

Messages

SYSTEM REPORT / TEST - ATA SELECTION

ATA ~ Select ATA to display functions ~

- ATA 26 Fire Protection
- ATA 27 Flight Control
- ATA 28 Fuel
- ATA 29 Hydraulic
- ATA 30 Ice and Rain
- ATA 31 Indicating Recording
- ATA 32 Landing Gear
- ATA 33 Lights
- ATA 34 Navigation
- ATA 36 Pneumatic
- ATA 38 Water / Waste
- ATA 45 OMS
- ATA 46 Information System
- ATA 49 Airbone Auxilary Pow
- ATA 52 Doors
- ATA 70 to 80 Power plant

ATA 70 to 80 - Power plant

BITE ~ Select function to choose BITE ~

- EEC 1
- EEC 2
- EEC 3
- EEC 4
- EIPM 1
- EIPM 2

SYSTEM REPORT / TEST - SIDE SELECTION

ATA 70 to 80 "Power plant"

"EEC 2"

~Select system to test~

"EEC 2A"

"EEC 2B"

SYSTEM REPORT / TEST - TEST SELECTION

ATA 70 to 80 "Power plant"

"EEC 2"

~Select test to perform~

Tests

Reports

Engine procedures

Specific functions

TESTS - EEC

FADEC MAINTENANCE (3)

Tests (continued)

EEC Tests

FADEC SYSTEM TEST
IGNITERS TEST

WARNING: IGNITERS WILL SPARK FOR 20 SECONDES DURING THE TEST.

Make sure that audibly the igniter is sparking.

FUEL DRIVEN ACTUATOR TEST

WARNING: WARNIING: WHILE THE ENGINE WILL TURN THE ENGINE ACTUATORS WILL MOVE DURING THE TEST.

Make sure that the engine area is clear of personnel before you start this test. This test can cause injuries to personnel and damage to equipment.

FUEL VALVE TEST (WET MOTOR)
AIR DRIVEN ACTUATOR TEST

WARNING: WHILE THE ENGINE WILL TURN THE ENGINE ACTUATORS WILL MOVE DURING TEST.

Make sure that the engine area is clear of personnel before you start this test. This test can cause injuries to personnel and damage to equipment.

HYDRAULIC PUMP OFFLOAD TEST

The engine will be dry cranked during the test.

WARNING: YOU SET THE CONTROLS AS SPECIFIED; THE DRY CRANK WILL START IMMEDIATELY. IN THIS TEST YOU MUST CHECK IF THE HYDRAULIC PRESSURE INCREASES AND DECREASES AT THE APPLICABLE TIMES.

HARNESS TEST

This test monitors the Full Authority Digital Engine Control (FADEC) system for 15 minutes and looks for faults while you shake the harness.

THRUST REVERSER CYCLING TEST

NOTE: This test is only done onto the EEC of the inboard engines.

Make sure that the thrust reverser is not in the inhibited position.

WARNING: THRUST REVERSER WILL BE ENERGIZED AND MOVED DURING THE TEST. MAKE SURE THAT THE THRUST REVERSER AREA IS CLEAR OF PERSONS AND CLEAN OF TOOLS OR OTHER ITEMS.

Move the throttle lever to reverse IDLE within 50 seconds, then move the throttle lever to forward IDLE within 50 seconds.

THRUST REVERSER MONITORING TEST

NOTE: Note: This test is only done onto the EEC of the inboard engines.

Make sure that the thrust reverser is not in the inhibited position.

WARNING: THRUST REVERSER WILL BE ENERGIZED AND MOVED DURING THE TEST. MAKE SURE THAT THE THRUST REVERSER AREA IS CLEAR OF PERSONS AND CLEAN OF TOOLS OR OTHER ITEMS.
REVERSER IS ENERGIZED AND WILL MAKE A PARTIAL DEPLOY/STOW SEQUENCE, THEN WILL BE FULLY DEPLOYED A FEW SECONDS LATER.

Move the throttle lever to reverse IDLE within 50 seconds, then move the throttle lever to forward IDLE within 50 seconds.

TESTS ARE SIMILAR FOR ALL ENGINES.BUT FOR THE INBOARD ENGINES THERE ARE TWO ADITIONAL TEST : "THRUST REVERSER CYCLING TEST"

EEC 2 CHAN A	TESTS	FADEC SYSTEM TEST	
		IGNITERS TEST	WARNING : IGNITERS WILL SPARK FOR 20 SEC. DURING TEST. MAKE SURE THAT AUDIBLY THE IGNITER IS SPARKING.
		FUEL DRIVEN ACTUATOR TEST	WARNING: THE ENGINE WILL TURN AND THE ENGINE ACTUATORS WILL MOVE DURING TEST. MAKE SURE THAT THE ENGINE AREA IS CLEAR OF PERSONNEL BEFORE YOU START THIS TEST. THIS TEST CAN CAUSE INJURIES TO PERSONNEL AND DAMAGE TO EQUIPMENT.
		FUEL VALVE TEST (WET MOTOR)	
		AIR DRIVEN ACTUATOR TEST	WARNING: WHILE THE ENGINE WILL TURN THE ENGINE ACTUATORS WILL MOVE DURING TEST MAKE SURE THAT THE ENGINE AREA IS CLEAR OF PERSONNEL BEFORE YOU START THIS TEST. THIS TEST CAN CAUSE INJURIES TO PERSONNEL AND DAMAGE TO EQUIPMENT.
		HYDRAULIC PUMP OFFLOAD TEST	THE ENGINE WILL BE DRY CRANKED DURING THE TEST. WARNING: YOU SET THE CONTROLS AS SPECIFIED; THE DRY CRANK WILL START IMMEDIATELY. IN THIS TEST YOU MUST CHECK IF THE HYDRAULIC PRESSURE INCREASES AND DECREASES AT THE APPLICABLE TIMES.
		HARNESS TEST	THIS TEST MONITORS THE FADEC SYSTEM FOR 5 MINUTES AND LOOKS FOR FAULTS WHILE YOU SHAKE THE HARNESS.
		THRUST REVERSER CYCLING TEST	MAKE SURE THAT THE THRUST REVERSER IS NOT IN INHIBITED POSITION. WARNING: THRUST REVERSER WILL BE ENERGIZED AND MOVED DURING THE TEST. MAKE SURE THAT THE THRUST REVERSER AREA IS CLEAR OF PERSONS AND CLEAN OF TOOLS OR OTHER ITEMS. MOVE THE THROTTLE LEVER TO REVERSE IDLE WITHIN 50 SECONDS. MOVE THE THROTTLE LEVER TO FORWARD IDLE WITHIN 50 SECONDS.
		THRUST REVERSER MONITORING TEST	MAKE SURE THAT THE THRUST REVERSER IS NOT IN INHIBITED POSITION. WARNING : THRUST REVERSER WILL BE ENERGIZED AND MOVED DURING THE TEST. MAKE SURE THAT THE THRUST REVERSER AREA IS CLEAR OF PERSONS AND CLEAN OF TOOLS OR OTHER ITEMS. WARNING: REVERSER IS ENERGIZED AND WILL MAKE A PARTIAL DEPLOY/STOW SEQUENCE, THEN WILL BE FULLY DEPLOYED A FEW SECONDS LATER. MOVE THE THROTTLE LEVER TO REVERSE IDLE WITHIN 50 SECONDS. MOVE THE THROTTLE LEVER TO FORWARD IDLE WITHIN 50 SECONDS.

TESTS - EEC TESTS

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FADEC MAINTENANCE (3)

Tests (continued)

Reports

The reports are the same for the two channels of the four EECs.

EEC CONFIGURATION
EGT EXCEEDANCE
SHAFT-SPEED REPORT
VIBRATION DATA REPORT
VIBRATION SPECTRA REPORT
OIL SYSTEM REPORT
STATUS OF A/C HARDWIRED INPUTS

Engine Procedures

ENGINE BALANCE
In the engine balance menu four procedures should be applied:
- Quick field balance
- Advanced balance
- VMU bearing accelerometer configuration
- Vibration data logger set-up

MANUAL ENGINE SERIAL NUMBER ENTRY
INHIBITION OF THRUST REVERSER
OIL DEBRIS MONITORING SYSTEM CHIP COUNT RESET

CAUTION: ONCE RESET, THE CHIP COUNT CAN NOT BE RESTORED.

Specific Functions

ENGINE RUNNING SIMULATION
Engine runs discrete signal simulation. The engine is not started for this test.

RESET FUEL USED

REPORTS, ENGINE PROCEDURES, AND SPECIFIC FUNCTIONS ARE SIMILAR FOR ALL ENGINES.
BUT FOR THE INBOARD ENGINES THERE IS AN ADITIONAL TEST : "INHIBITION OF THRUST REVERSER"

EEC 2 CHAN A	REPORTS	EEC CONFIGURATION	
		EGT EXCEEDANCE	
		SHAFT-SPEED REPORT	
		VIBRATION DATA REPORT	
		VIBRATION SPECTRA REPORT	
		OIL SYSTEM REPORT	
		STATUS OF A/C HARDWIRED INPUTS	
	ENGINE PROCEDURES	ENGINE BALANCE	QUICK FIELD BALANCE
			ADVANCED BALANCE
			VMU 1 BEARING ACCELEROMETER CONFIGURATION
			VIBRATION DATA LOGGER SET-UP
		MANUAL ENGINE SERIAL NUMBER ENTRY	
		INHIBITION OF THRUST REVERSER	
		OIL DEBRIS MONITORING SYSTEM CHIP COUNT RESET	CAUTION: ONCE RESET, THE CHIP COUNT CAN NOT BE RESTORED
	SPECIFIC FUNCTIONS	ENGINE RUNNING SIMULATION	ENGINE RUNNING DISCRETE SIGNAL SIMULATION. THE ENGINE IS NOT STARTED FOR THIS TEST.
		RESET FUEL USED	

TESTS - REPORTS ... SPECIFIC FUNCTIONS

FADEC MAINTENANCE (3)

Tests (continued)

EIPM

To reach the "TEST SELECTION" page, you must select the ATA 70 to 80 "Power Plant" and the system to test in the "ATA SELECTION" page (EEC 1 to EEC 4, EIPM 1 or EIPM 2). Then you select the channel dedicated to an engine in the "SIDE SELECTION" page.
The EIPM gives the following interactive tests, reports and Specific function:

Tests

The tests are the same for each EIPM.

FADEC GROUND POWER "ON"LIGHT
ENGINE MASTER "FAULT" LIGHT

Reports

The reports are the same for each EIPM.

DISCRETE INPUTS REPORTS
DISCRETE OUTPUTS REPORTS
PIN PROGRAMMING REPORTS

Specific Function

OIL LOW PRESS AND GROUND

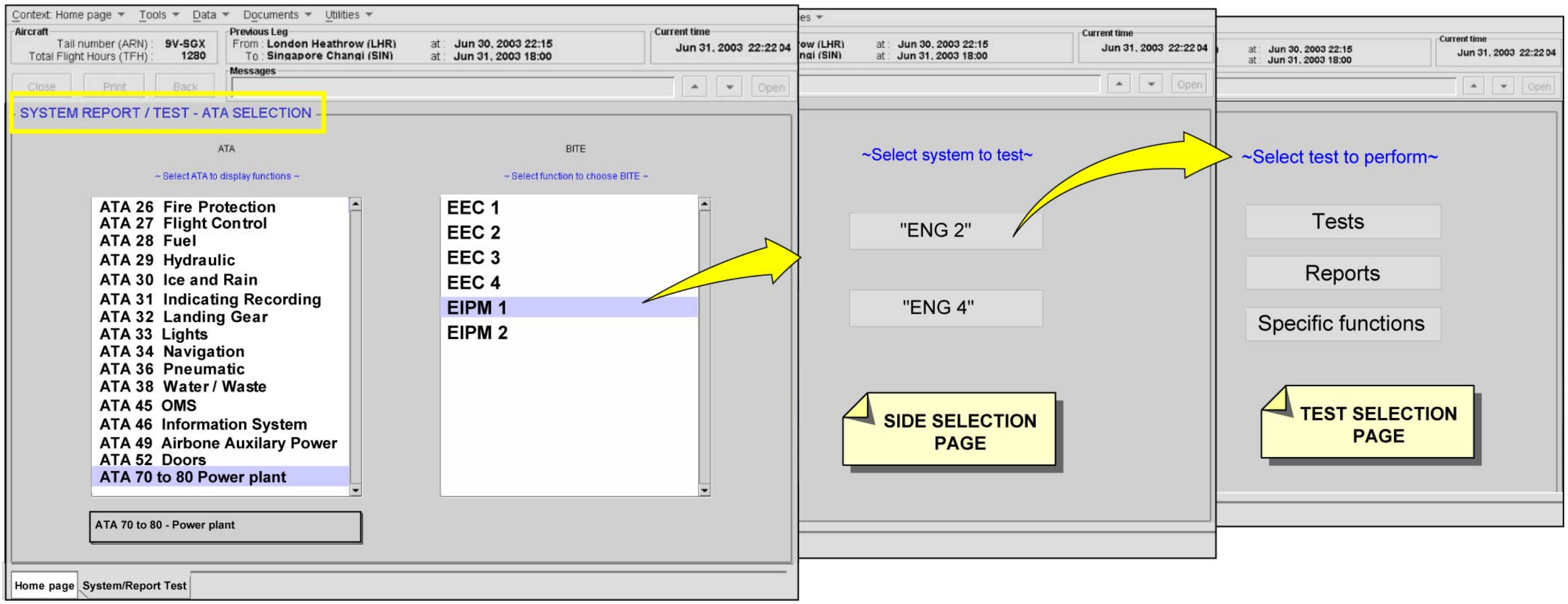
On the EIPM 1 ENG 2 and the EIPM 2 ENG 3 there are two other specific functions:

THRUST REVERSER 3 PHASE 115 V / 25 KW POWER SUPPLY

WARNING: REVERSE SECOND LINE OF DEFENSE WILL BE DEACTIVATED; POSSIBLE REVERSE DOORS ACTIVATION CAN OCCUR.

ETRAC MANUAL POWER SUPPLY

WARNING: ELECTRONIC THRUST REVERSER ACTUATION CONTROLLER (ETRAC) WILL BE POWER SUPPLIED; POSSIBLE REVERSE DOORS ACTIVATION CAN OCCUR.



Aircraft
Tail number (ARN) : 9V-SGX
Total Flight Hours (TFH) : 1280

Previous Leg
From : London Heathrow (LHR) at : Jun 30, 2003 22:15
To : Singapore Changi (SIN) at : Jun 31, 2003 18:00

Current time
Jun 31, 2003 22:22 04

Messages

SYSTEM REPORT / TEST - ATA SELECTION

- ATA 26 Fire Protection
- ATA 27 Flight Control
- ATA 28 Fuel
- ATA 29 Hydraulic
- ATA 30 Ice and Rain
- ATA 31 Indicating Recording
- ATA 32 Landing Gear
- ATA 33 Lights
- ATA 34 Navigation
- ATA 36 Pneumatic
- ATA 38 Water / Waste
- ATA 45 OMS
- ATA 46 Information System
- ATA 49 Airbone Auxilary Power
- ATA 52 Doors
- ATA 70 to 80 Power plant

ATA 70 to 80 - Power plant

- EEC 1
- EEC 2
- EEC 3
- EEC 4
- EIPM 1
- EIPM 2

~Select system to test~

"ENG 2"

"ENG 4"

SIDE SELECTION PAGE

~Select test to perform~

Tests

Reports

Specific functions

TEST SELECTION PAGE

TESTS, REPORTS AND SPECIFIC FUNCTIONS ARE SIMILAR FOR ALL ENGINES. BUT FOR THE INBOARD ENGINES THERE ARE TWO ADDITIONAL SPECIFIC FUNCTIONS : "THRUST REVERSER 3 PHASE 115 V / 25 KW POWER SUPPLY" AND "ETRAC MANUAL POWER SUPPLY"

EIPM 1 ENG 2	TESTS	FADEC GROUND POWER "ON" LIGHT	
		ENGINE MASTER "FAULT" LIGHT	
	REPORTS	DISCRETE INPUTS REPORTS	
		DISCRETE OUPUTS REPORTS	
		PIN PROGRAMMING REPORTS	
	SPECIFIC FUNCTIONS	OIL LOW PRESS AND GROUND	
		THRUST REVERSER 3 PHASE115 V / 25 KW POWER SUPPLY	WARNING : REVERSE SECOND LINE OF DEFENSE WILL BE DEACTIVATED => POSSIBLE REVERSE DOORS ACTIVATION
		ETRAC MANUAL POWER SUPPLY	WARNING : ETRAC WILL BE POWER SUPPLIED => POSSIBLE REVERSE DOORS ACTIVATION

TESTS - EIPM ... SPECIFIC FUNCTION

ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)

General

Let's see the general view of the A380 cockpit.

GENERAL

LB408521 - L5CT0T0 - LM7EO2LEVEL0301

ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)

General (continued)

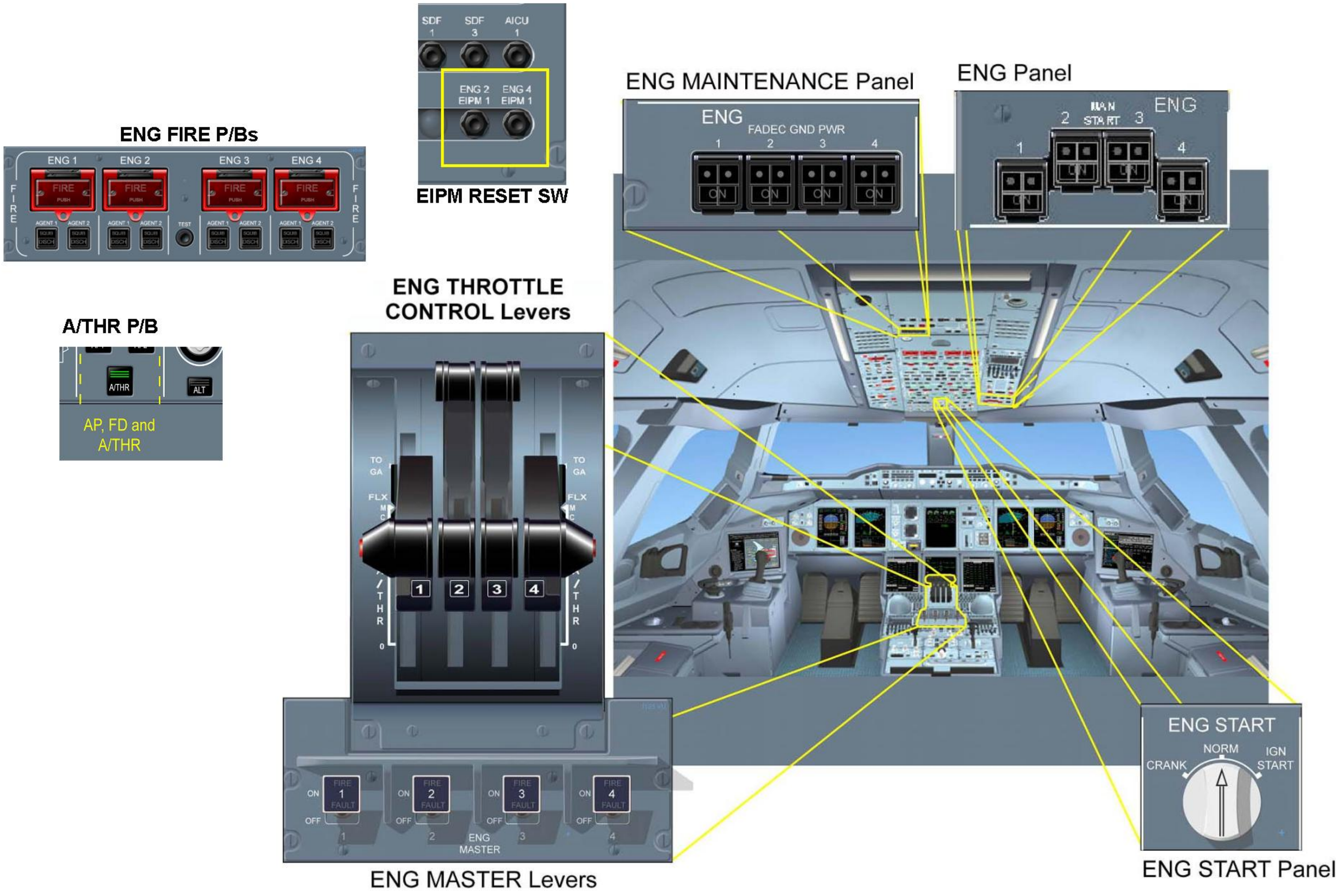
Preliminary Cockpit Preparation

Before operating the engines the operator must obey the preliminary checklists for cockpit preparation:
- Control safety checklist,
- A/C powering with external power,
- APU start checklist,
- Pneumatic and air conditioning activation.

Engine Control Panels Location

The engine control panels are located on the overhead panel:
- the EIPM 1 & 2 reset circuit breakers,
- the ENGINE FADEC GND PWR panel,
- the ENGine FIRE panel,
- the ENG MANual START panel,
- the ENG START panel.

An autothrust (A/THR) P/B is located on the glareshield and on the pedestal there are:
- the Engine Throttle Control Levers with the instinctive disconnect P/Bs and the reverse thrust reverser levers on the engine 2 and 3 only,
- the ENG MASTER levers panel.


ENG FIRE P/Bs
ENG 1
ENG 2
ENG 3
ENG 4
FIRE
FIRE
PUSH
AGENT 1
AGENT 2
SQUIB
DISCH
TEST
SDF 1
SDF 3
AICU 1
ENG 2 EIPM 1
ENG 4 EIPM 1
EIPM RESET SW
ENG MAINTENANCE Panel
ENG
FADEC GND PWR
1
2
3
4
ON
ENG Panel
ENG
MAN START
1
2
3
4
ON
A/THR P/B
A/THR
ALT
AP, FD and A/THR
ENG THROTTLE CONTROL Levers
TO GA
FLX M C
A/THR
0
1
2
3
4
ON
OFF
FIRE
FAULT
ENG MASTER
ENG MASTER Levers
ENG START
NORM
CRANK
IGN START
ENG START Panel

GENERAL - PRELIMINARY COCKPIT PREPARATION & ENGINE CONTROL PANELS LOCATION

ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)

Engine Controls and Indication Presentation

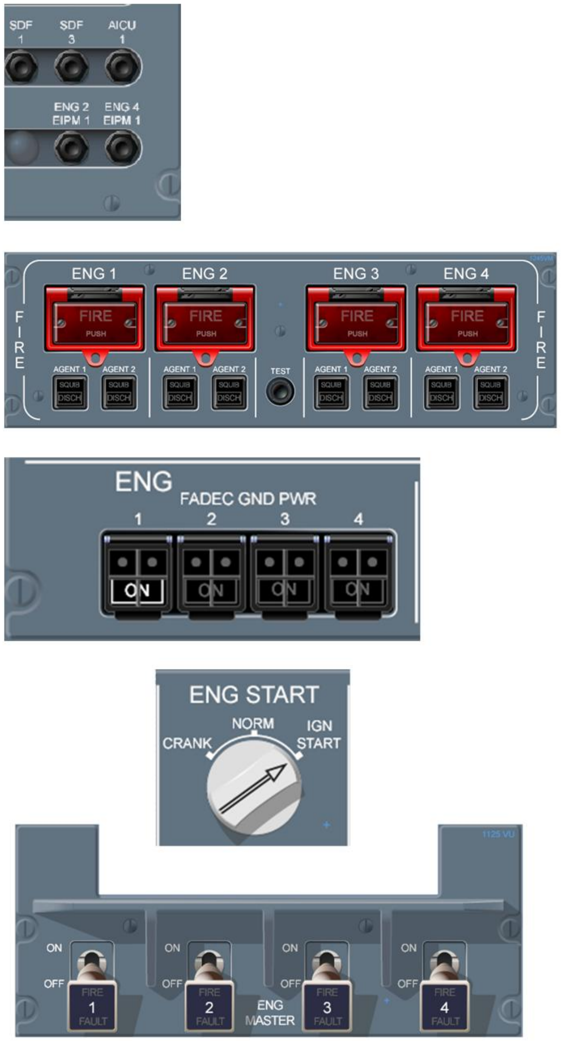
EEC Powering / Depowering

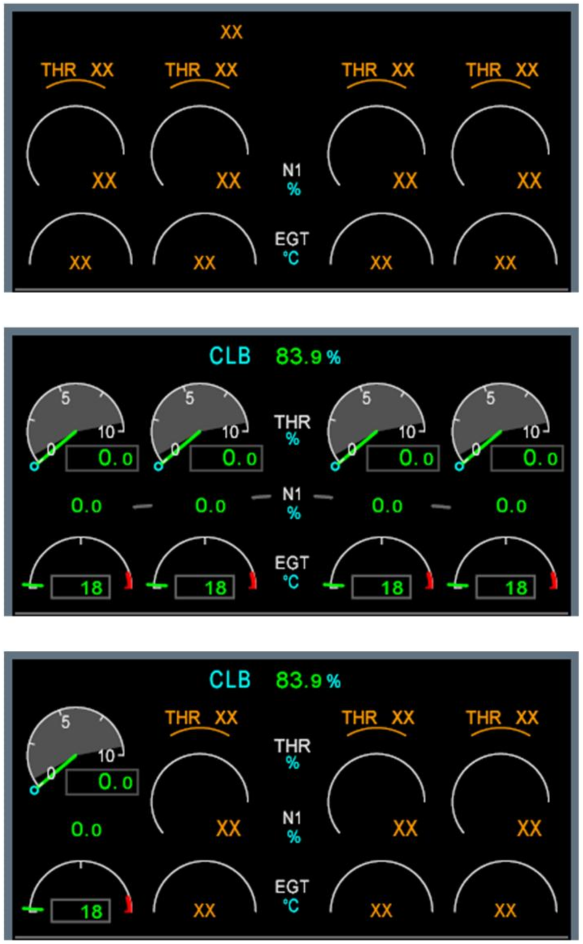
By setting the ENG START selector switch to the CRANK or IGN START position with engines not running the FADEC is powered. The corresponding indication is clearly displayed on the EWD and the amber "XX" which were displayed due to the absence of information are replaced by the main thrust parameters.
Also when you press the FADEC GND PWR P/BSW to ON, the FADEC parameters are clearly displayed on the EWD and the amber "XX" are replaced by the main thrust parameters. If the FADEC GND PWR P/BSW remains ON, this means that the FADEC is powered for 10 min, except if OMS in interactive mode. In this case the FADEC stays automatically energized as long as you are in the related EEC tests menu. After these 10 min, on FADEC GND PWR panel, the ON legend goes off automatically.

NOTE: The ENG MASTER lever can be used for powering the FADEC.
In this case, the dedicated FADEC will be powered for 15 minutes, but it is not recommended on the A/C because there is a risk of the engine being started if the rotary selector has been put in the IGN START position.
If you do, perform quick ON and OFF action, because you must remember that when the ENG MASTER lever is set to ON, the LP fuel SOV is commanded open.

When you push a FADEC GrouND POWER SW to ON, on EWD the amber "XXs" are replaced by the main thrust parameters.
If switch remains ON, the FADEC is powered for 10 minutes except if the OMS is in interactive mode. In this case the FADEC stays automatically energized as long as you are in the related EEC tests menu.
After 10 minutes, the ON legend of FADEC GrouND PoWeR panel is automatically off.
If the EIPM reset switches are pulled for maintenance purposes, the dedicated EECs are fail-safe powered. The ENGINE FIRE P/BSW also has effects on the EEC powering/depowering. When this P/BSW is released out, it has effects on the various aircraft systems such as:
- FADEC power supply is cut,
- the hydraulic system: closure of the fire shut-off valves in order to isolate the hydraulic pumps from the reservoir,
- the electrical system,
- the bleed system,
- the fuel system: closure of the engine LP valve.

CAUTION: WITH ENG FIRE PUSH BUTTON RELEASED OUT, THE FIRE EXTINGUISHERS ARE ARMED. DO NOT PRESS ON THE AGENT P/BSWs.


SDF 1
SDF 3
AICU 1
ENG 2 EIPM 1
ENG 4 EIPM 1
FIRE
ENG 1
ENG 2
ENG 3
ENG 4
FIRE PUSH
AGENT 1
AGENT 2
SQUIB DISCH
TEST
ENG
FADEC GND PWR
1
2
3
4
ON
ENG START
CRANK
NORM
IGN START
ON
OFF
FIRE
FAULT
ENG MASTER
1125 VU


XX
THR XX
N1 %
EGT °C
CLB 83.9 %
THR %
5
10
0.0
18

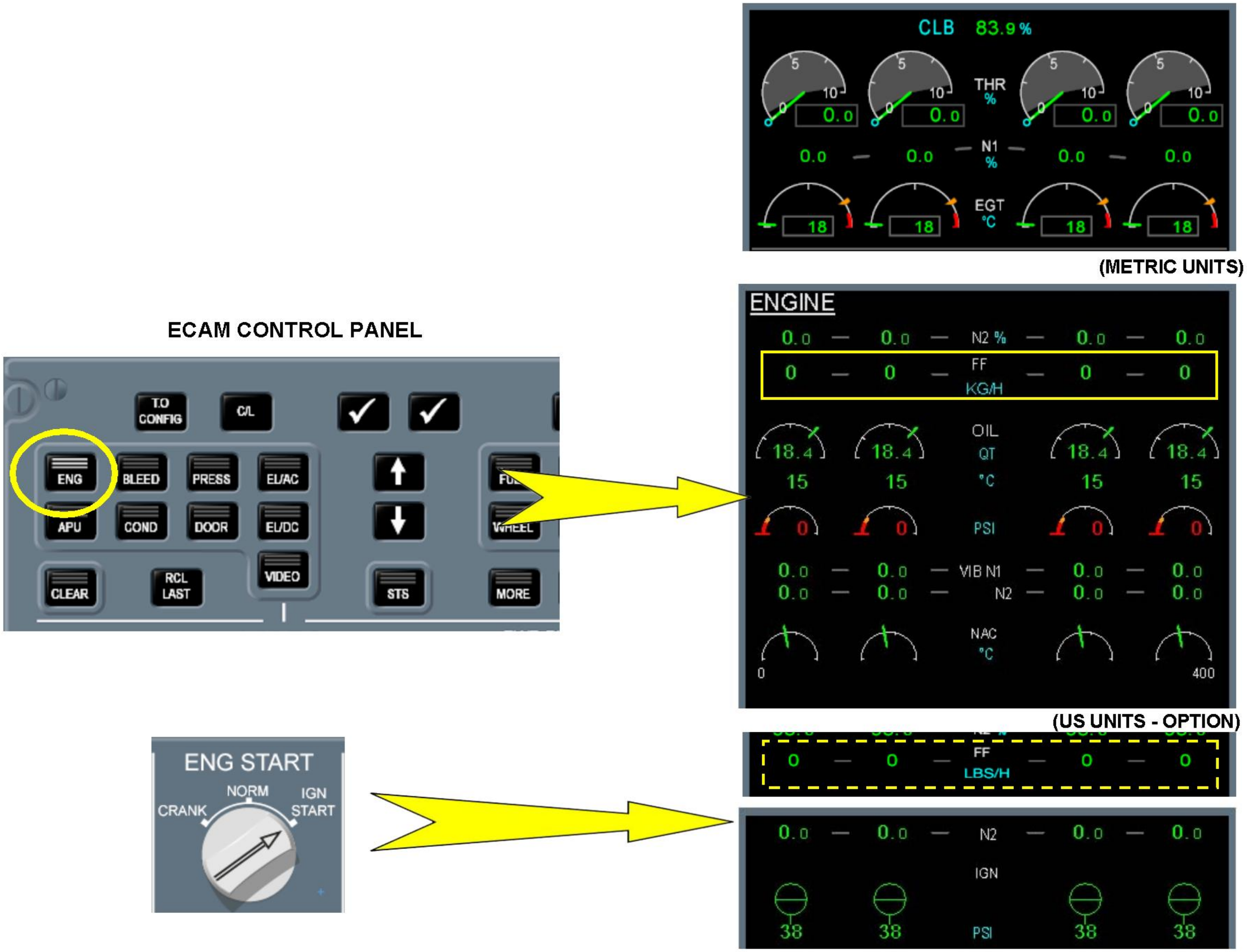
ENGINE CONTROLS AND INDICATION PRESENTATION - EEC POWERING / DEPOWERING

ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)

Engine Controls and Indication Presentation (continued)

Engine Parameters Display

Among the main parameters displayed on the EWD, you have the thrust mode indication (CLB, MCT, TO) and the thrust (THR).
The LP Rotor Speed (N1) and EGT indications are also displayed.
The ECAM ENGINE page can be called by the selection of the ENG key on the ECAM Control Panel (ACP) located on the pedestal.
The secondary engine parameters, which are shown on the ECAM ENGINE page, are:
- HP Rotor speed (N2)
- Fuel Flow (FF),
- Engine oil quantity (OIL QTY),
- Engine oil temperature (OIL TEMP),
- Engine oil pressure (OIL PRESS),
- Engine rotor vibration levels (N1, N2),
- Nacelle temperature (NAC) from 0 to 400°C.


CLB 83.9 %
THR %
N1 %
EGT °C
(METRIC UNITS)
ENGINE
N2 %
FF KG/H
OIL QT °C
PSI
VIB N1 N2
NAC °C
ECAM CONTROL PANEL
T.O CONFIG
C/L
ENG
BLEED
PRESS
EL/AC
APU
COND
DOOR
EL/DC
VIDEO
CLEAR
RCL LAST
STS
MORE
(US UNITS - OPTION)
FF LBS/H
ENG START
CRANK
NORM
IGN START
N2
IGN
PSI

ENGINE CONTROLS AND INDICATION PRESENTATION - ENGINE PARAMETERS DISPLAY

ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)

Engine Controls and Indication Presentation (continued)

Throttle Control Levers

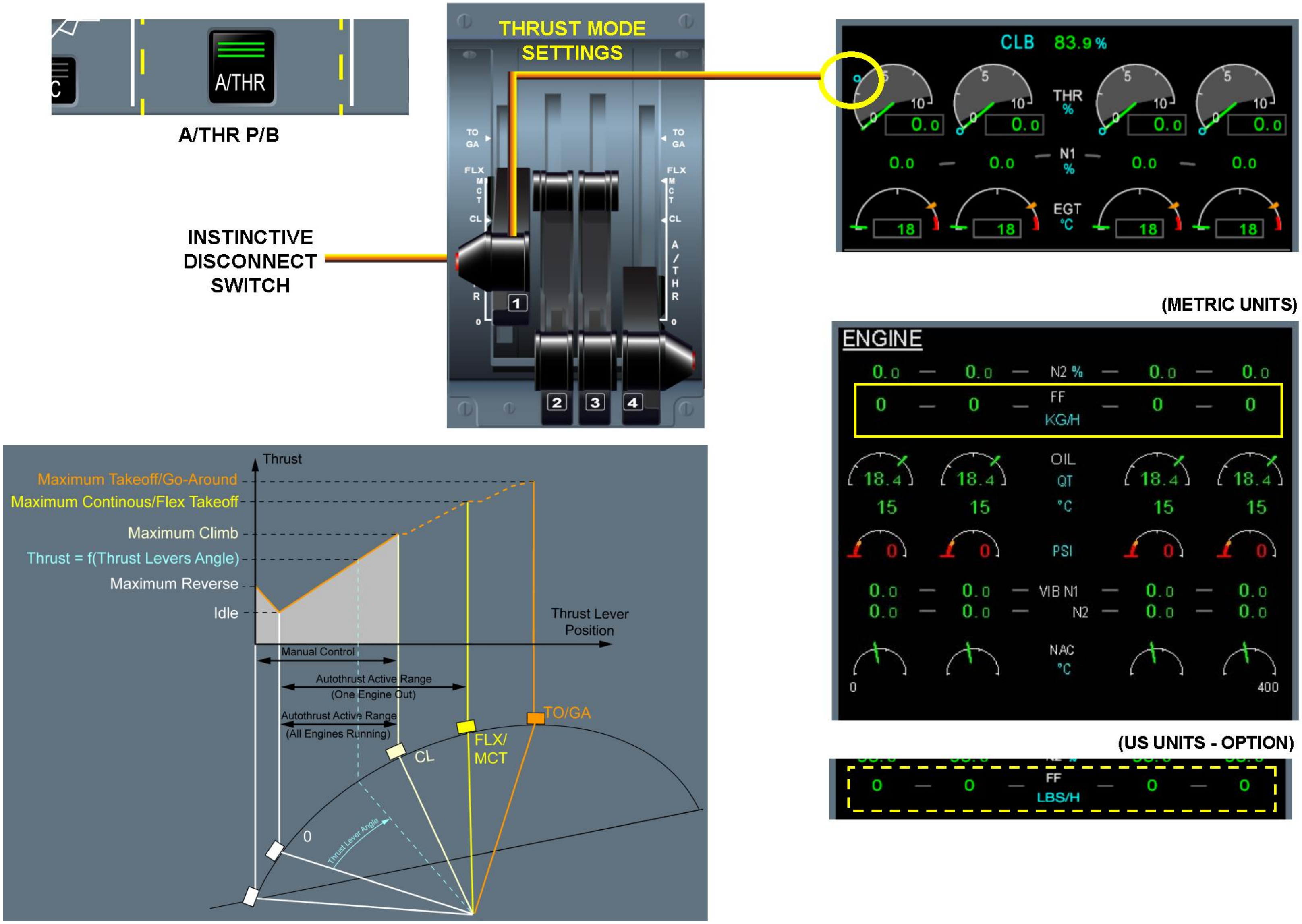
The throttle control levers can be individually moved and manually only, they are used to adjust the aircraft forward thrust. The range of the levers movement is divided into 4 detent points: 0 (IDLE), CL for climb, FLX/MCT and TO/GA. When you supply an engine FADEC for example, by pushing the FADEC GND PWR P/BSW to ON and when you move the corresponding throttle control lever, you will see the displacement of the cyan circle on the EWD THR indicator. The thrust mode corresponding to the lever position is also displayed on the upper part of the EWD.

On the Throttle Control Lever, are the reverser levers to control the deployment or the stowing of the reversers and adjust the reverse thrust. These thrust reversers are installed on the engine 2 and 3 only. The reverser levers move between two detents: IDLE and full reverse thrust.

Two A/THR instinctive disconnect P/BSWs (red) are located on the throttle control levers (engines 1 and 4 only). They direct input to all EECs in order to disconnect the A/THR function as soon as one of them is pushed.

A/THR P/B

An A/THR P/B is located on the Flight Control Unit (FCU) section of the glareshield. When it is pressed, three green lines on this P/BSW illuminate. The green lines go off when any instinctive disconnect P/B is pressed or when you press the A/THR P/B again.


A/THR
A/THR P/B
THRUST MODE SETTINGS
INSTINCTIVE DISCONNECT SWITCH
TO GA
FLX
MCT
CL
A/THR
R
0
1
2
3
4
CLB 83.9%
THR %
N1 %
EGT °C
0.0
18
(METRIC UNITS)
ENGINE
N2 %
FF KG/H
OIL QT
°C
PSI
18.4
15
VIB N1
N2
NAC °C
0
400
(US UNITS - OPTION)
FF LBS/H
Thrust
Maximum Takeoff/Go-Around
Maximum Continous/Flex Takeoff
Maximum Climb
Thrust = f(Thrust Levers Angle)
Maximum Reverse
Idle
Thrust Lever Position
Manual Control
Autothrust Active Range (One Engine Out)
Autothrust Active Range (All Engines Running)
TO/GA
FLX/MCT
CL
0
Thrust Lever Angle

ENGINE CONTROLS AND INDICATION PRESENTATION - THROTTLE CONTROL LEVERS & A/THR P/B

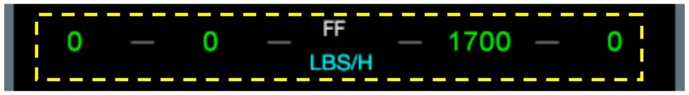
ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)

Engine Operation

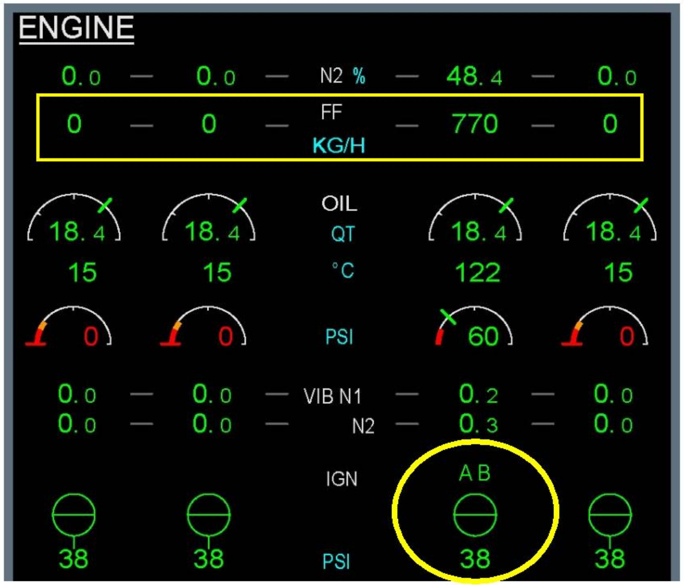
Continuous Ignition

Selecting the ENG START rotary to IGN/START position with the engine running performs the engine continuous relight. An automatic relight occurs in case of a flameout detected by EEC.
In case of inadvertent selection of MASTER lever to OFF in flight only, the pilot has possibility to relight the engine within 30 seconds, by cycling the MASTER lever back to ON. This is the quick relight function.

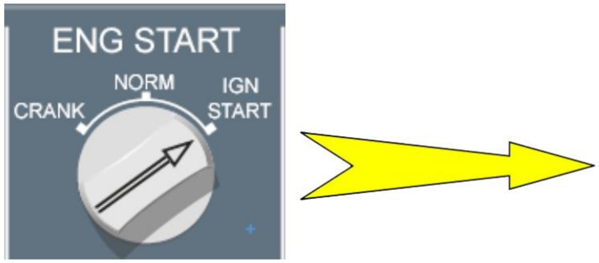
(US UNITS - OPTION)

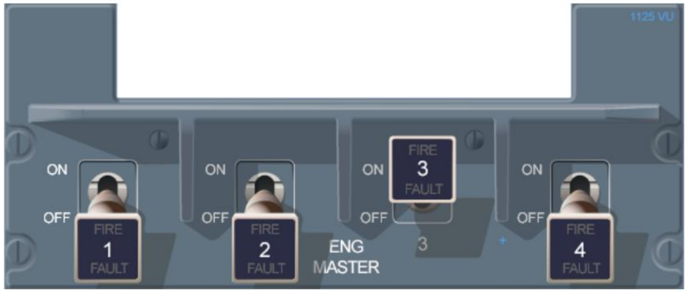

0 — 0 — FF — 1700 — 0
LBS/H

(METRIC UNITS)


ENGINE
0. 0 — 0. 0 — N2 % — 48. 4 — 0. 0
0 — 0 — FF — 770 — 0
KG/H
OIL
18. 4
18. 4
QT
18. 4
18. 4
15
15
°C
122
15
0
0
PSI
60
0
0. 0 — 0. 0 — VIB N1 — 0. 2 — 0. 0
0. 0 — 0. 0 — N2 — 0. 3 — 0. 0
IGN
A B
38
38
PSI
38
38

CONTINUOUS RELIGHT MANUAL SELECTION


ENG START
CRANK
NORM
IGN START


1125 VU
ON
OFF
FIRE
1
FAULT
ON
OFF
FIRE
2
FAULT
ON
OFF
FIRE
3
FAULT
3
ENG MASTER
ON
OFF
FIRE
4
FAULT

ENGINE OPERATION - CONTINUOUS IGNITION

ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)

Engine Operation (continued)

N1 Degraded Mode

If one air data parameter from Air Data and Inertial Reference Units (ADIRUs) and engine is totally lost (PS and P0, PT & PS12/PT2, TAT & T12), an "ENG NORM MODE FAULT" warning message is displayed on the EWD. The THR indicator is flagged with amber "XXs". So, the EEC has reverted automatically into N1 degraded mode and the thrust dial is replaced by N1 dial.

FAULT SYMPTOM:

-TOTAL LOSS OF ONE AIR DATA PARAMETER FROM ADIRUS AND ENGINE:
-PS & P0
-PT & PS12/PT2
-TAT & T12

WARNING MESSAGE:

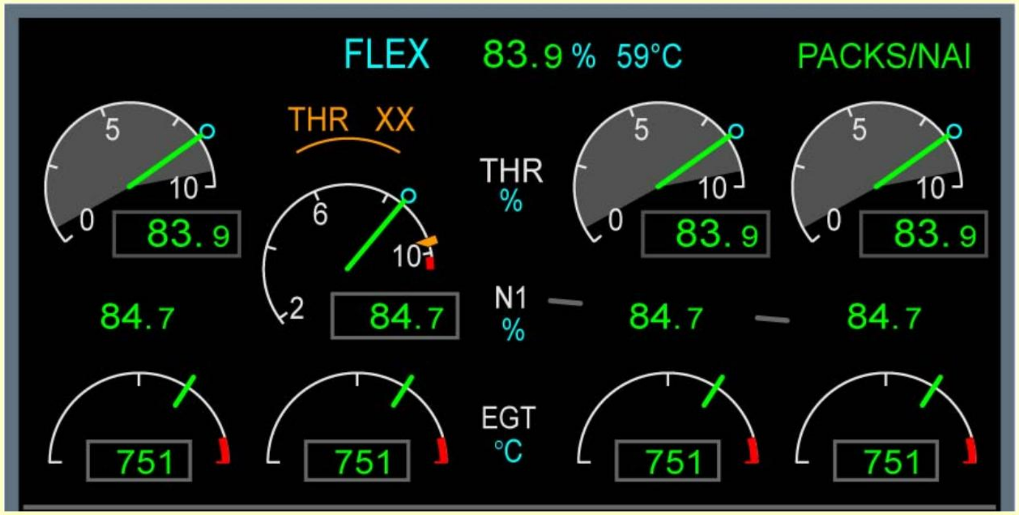
-ENG NORM MODE FAULT

CONSEQUENCE:

-THE EEC HAS REVERTED AUTOMATICALLY INTO N1 DEGRADED MODE.

-CORRESPONDING THR INDICATOR FLAGGED WITH AMBER “THR XX”.

-THRUST DIAL REPLACED BY N1 DIAL..


FLEX
83.9 %
59°C
PACKS/NAI
THR XX
THR
%
N1
%
EGT
°C
5
10
0
83.9
6
10
2
84.7
84.7
84.7
84.7
83.9
83.9
751
751
751
751

ENGINE OPERATION - N1 DEGRADED MODE

ENGINE & FADEC SYSTEMS OPS/CTL & IND (3)

Engine Operation (continued)

Engine Parameters Faults

Engine secondary parameters also indicate some faults when they occur. An amber CLOGGED flag under the fuel flow indicates that the fuel filter is clogged. The amber ENG FUEL FILTER CLOGGED message is displayed on the EWD.

CAUTION: YOU MUST NOT OPERATE THE ENGINE IF THE FUEL FILTER IS CLOGGED. CONTAMINATED FUEL CAN BYPASS THE FILTER AND CAUSE DAMAGE TO THE ENGINE. REPLACE THE FUEL FILTER BEFORE YOU OPERATE THE ENGINE AGAIN.

The rotor vibration levels are also to be monitored VIB N1, N2), when these VIB indications are above a specific threshold (2.8 cockpit units) they pulses green. In case of fan unbalance, there can be a sound effect. In case of N1 high vibration detected, a fan trim balance procedure has to be done. So, get acquisition of FAN UNBALANCE report from EMU.

The engine oil low pressure can drop when the engine is running. In this case the green oil pressure value reverts to amber and becomes red if it drops below 25°PSI. The red ENG OIL PRESS LO message is displayed on the EWD, the MASTER WARNING lights flash, the Continuous Repetitive Chime (CRC) sounds and the ENGINE SD page is automatically displayed.

FAULT SYMPTOM:

- LP FUEL FILTER CONTAMINATION

WARNING MESSAGE:

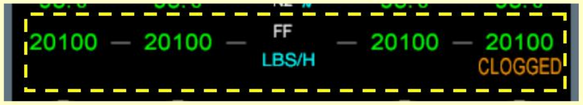
- ENG FUEL FILTER CLOGGED

CONSEQUENCE:

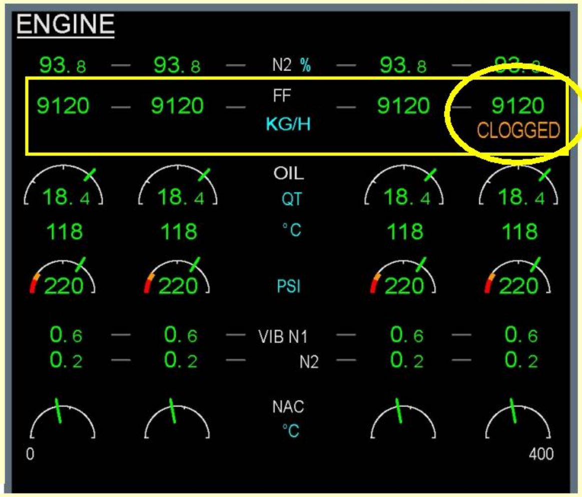
- **CLOGGED** indication appears in amber under the Fuel Flow indication.

- Fuel filter inspection and change required before next flight.

(US UNITS – OPTION)


20100
20100
FF
LBS/H
20100
20100
CLOGGED

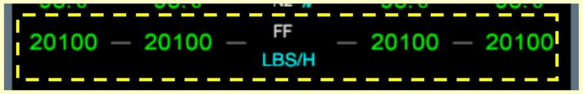
(METRIC UNITS)


ENGINE
93.8
93.8
N2 %
93.8
93.8
9120
9120
FF
KG/H
9120
9120
CLOGGED
OIL
QT
°C
PSI
18.4
118
220
0.6
0.2
VIB N1
N2
NAC
°C
0
400

FAULT SYMPTOM:

-HIGH N1 VIBRATION

(US UNITS – OPTION)


20100
20100
FF
LBS/H
20100
20100

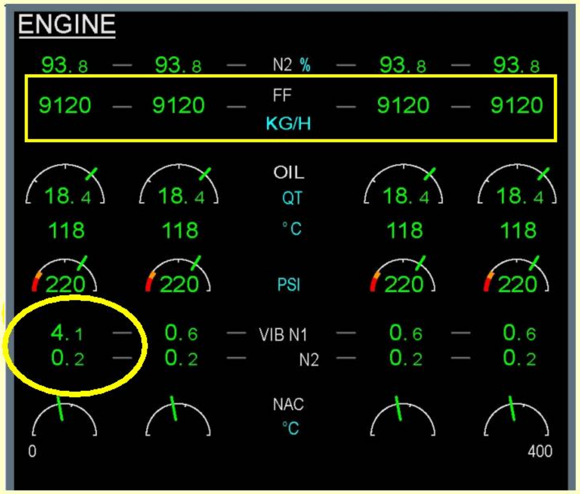
ADVISORY:

-N1 vibration indication pulses green

CONSEQUENCE:

- ECAM Advisory, If N1 vibrations limit is reached (2.8 Cockpit Unit),
- Engine fan unbalance,
- Compressor rumble noises could be heard.

(METRIC UNITS)


ENGINE
93.8
N2 %
9120
FF
KG/H
OIL
QT
°C
PSI
18.4
118
220
4.1
0.2
0.6
0.2
VIB N1
N2
NAC
°C
0
400

ENGINE OPERATION - ENGINE PARAMETERS FAULTS

FAULT SYMPTOM:

- ABNORMAL OIL PRESSURE DROP

WARNING MESSAGE:

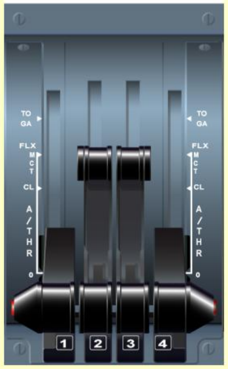
- ENG OIL PRESS LO

CONSEQUENCE:

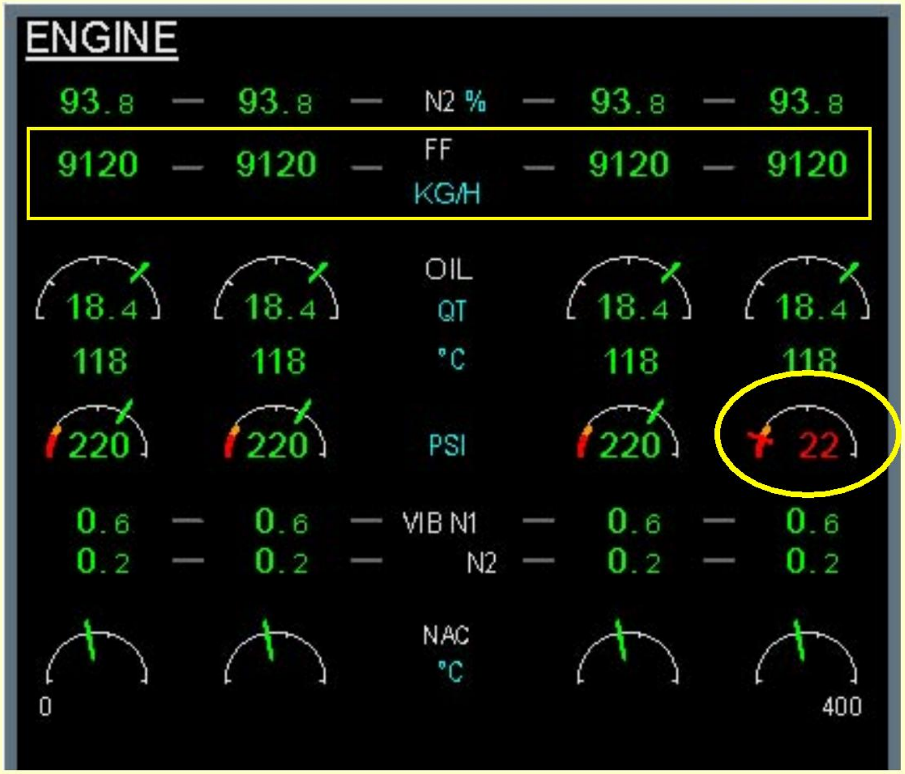
- The oil pressure quadrant shows a low pressure value.

If the oil pressure reduces below red line limit (25 psi):

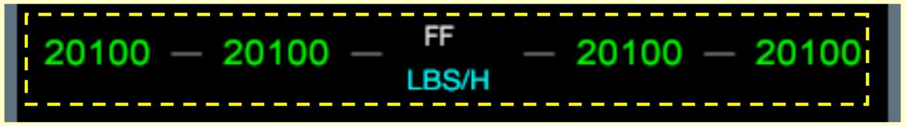
- Reduce THROTTLE CONTROL LEVER to Idle stop,
- Initiate an engine shutdown, to avoid engine damage.


TO GA
FLX
MCT
CL
A/THR
0
1
2
3
4

(METRIC UNITS)


ENGINE
93.8 — 93.8 — N2 % — 93.8 — 93.8
9120 — 9120 — FF KG/H — 9120 — 9120
OIL
18.4 18.4 QT 18.4 18.4
118 118 °C 118 118
220 220 PSI 220 22
0.6 — 0.6 — VIB N1 — 0.6 — 0.6
0.2 — 0.2 — N2 — 0.2 — 0.2
NAC °C
0
400

(US UNITS – OPTION)


20100 — 20100 — FF LBS/H — 20100 — 20100

ENGINE OPERATION - ENGINE PARAMETERS FAULTS

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THRUST REVERSER DESCRIPTION (EA) (3)

Electrical Thrust Reverser Actuation System - General

Purpose

The Electrical Thrust Reverser Actuation System (ETRAS) is an electro-mechanical system used to actuate and lock the thrust reverser transcowls.
ETRAS also provides a manual drive unit to deploy or stow the thrust reverser transcowls manually during maintenance operation.

Location

Most of the components are located an the thrust reverser forward frame
Tertiary Lock System (TLS) on the 6 o'clock rear beam

Components

6 actuators,
6 flexshafts,
Electronic Thrust Reverser Actuation Controller (ETRAC),
Thrust Reverser Power Unit (TRPU),
Power Drive Unit (PDU) with brake,
2 Primary Locks (PLS) integrated to the upper actuators,
2 Manual Drive Units (MDU) integrated with the middle actuators,
Tertiary Lock System (TLS)
TLS Power Unit (TLSPU),
2 resolvers integrated with the lower actuators,
Electrical harnesses (power and control/monitoring).

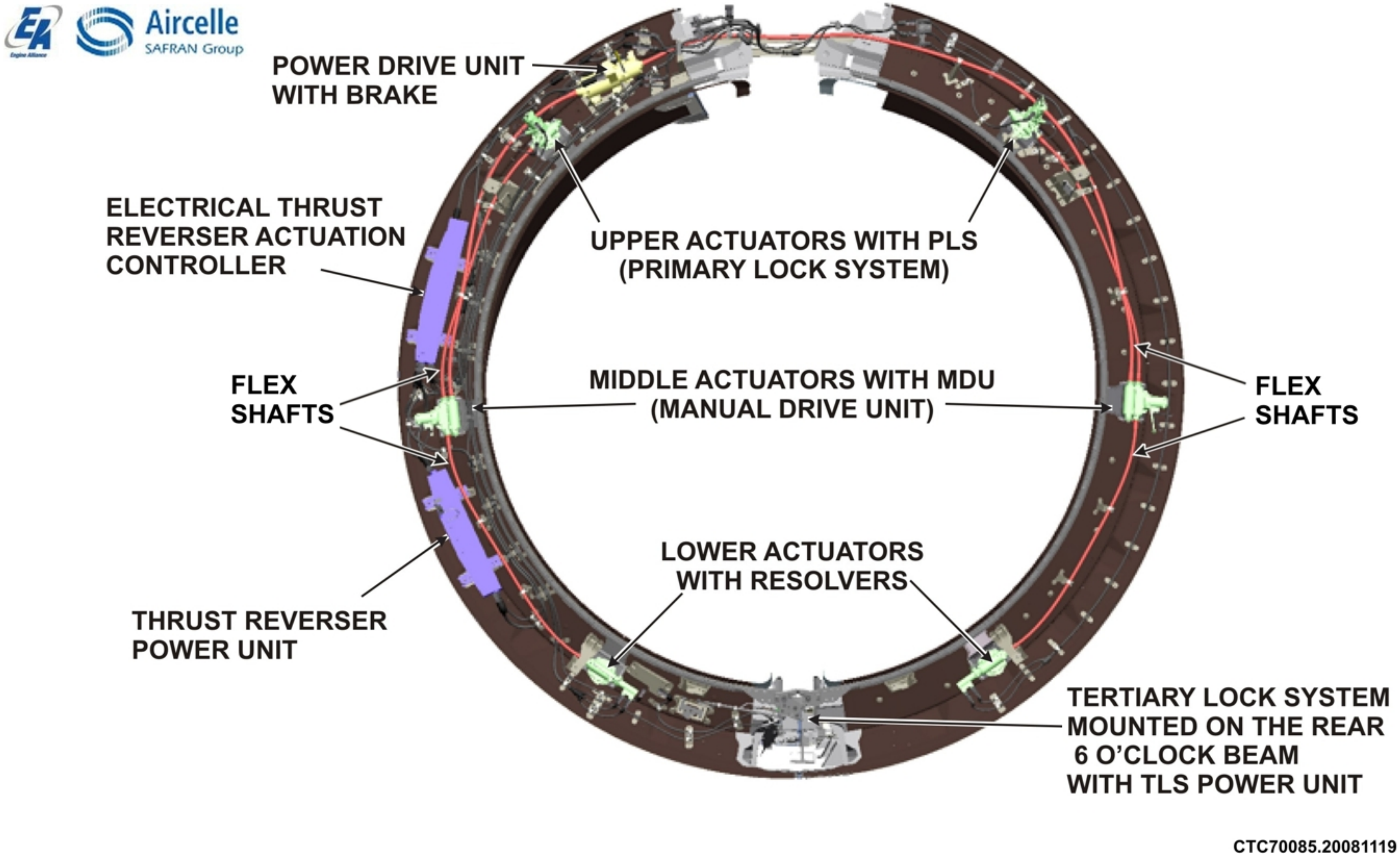
Description and Operation

In flight, the ETRAS securely retains both transcowls stowed and locked by three means of retention:
- Two primary locks,
- One tertiary lock.

During reverse thrust operation, the ETRAS translates the transcowls in deploy or stow direction upon reception of the aircraft and EEC commands.
Both transcowls are mechanically linked and slide on thrust reverser upper and lower tracks.
Transcowls deployment and stowage is done with six ballscrew actuators driven by rotating flexshafts that are linked to a power drive unit.

LRUs

All components listed in this chapter.


Aircelle
SAFRAN Group
POWER DRIVE UNIT WITH BRAKE
ELECTRICAL THRUST REVERSER ACTUATION CONTROLLER
UPPER ACTUATORS WITH PLS (PRIMARY LOCK SYSTEM)
FLEX SHAFTS
MIDDLE ACTUATORS WITH MDU (MANUAL DRIVE UNIT)
FLEX SHAFTS
LOWER ACTUATORS WITH RESOLVERS
THRUST REVERSER POWER UNIT
TERTIARY LOCK SYSTEM MOUNTED ON THE REAR 6 O'CLOCK BEAM WITH TLS POWER UNIT
CTC70085.20081119

ELECTRICAL THRUST REVERSER ACTUATION SYSTEM - GENERAL - PURPOSE ... LRUS

THRUST REVERSER DESCRIPTION (EA) (3)

Primary Lock System

Purpose

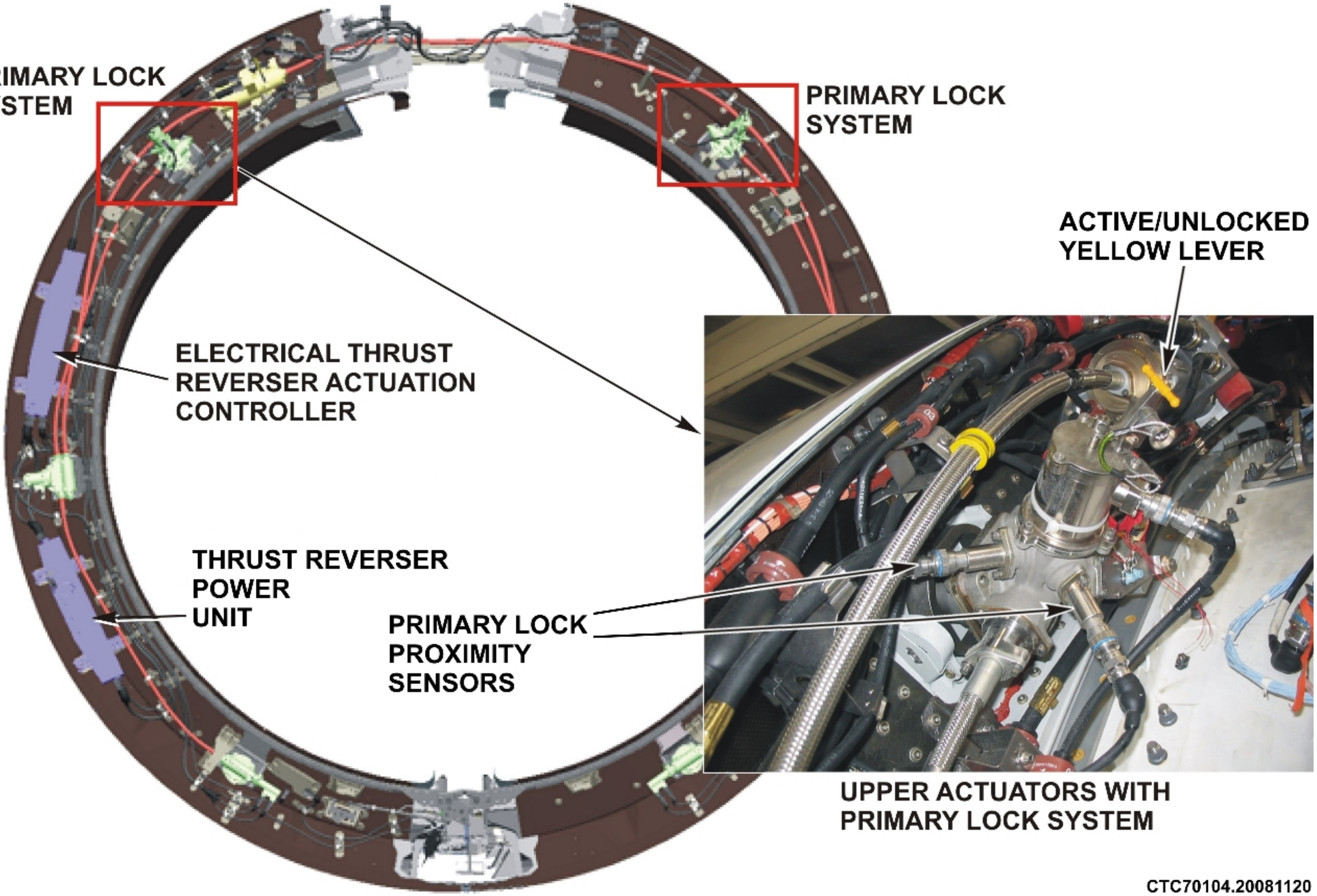
The Primary Lock System (PLS) locks the thrust reverser transcowls when stowed to prevent inadvertent thrust reverser deployment in flight.

Location

A primary lock system is mounted on each of the two upper actuators at 1 o'clock and 11 o'clock.

Description and Operation

The right PLS receives the unlock command from the Electrical Thrust Reverser Actuation Controller (ETRAC).
The left PLS receives the unlock command from the Thrust Reverser Power Unit (TRPU).
Two sensors are mounted on each of the primary locks to notify the EEC of the lock status.
The locks automatically relock at the end of reverse stowage.
The right and left PLS have a yellow lever with a quick release pin to permit manual operation of the transcowl for maintenance and troubleshooting.


PRIMARY LOCK SYSTEM
PRIMARY LOCK SYSTEM
ACTIVE/UNLOCKED YELLOW LEVER
ELECTRICAL THRUST REVERSER ACTUATION CONTROLLER
THRUST REVERSER POWER UNIT
PRIMARY LOCK PROXIMITY SENSORS
UPPER ACTUATORS WITH PRIMARY LOCK SYSTEM
CTC70104.20081120

PRIMARY LOCK SYSTEM - PURPOSE ... DESCRIPTION AND OPERATION

LB408521 - L5CT0T0 - LM7E9Y000000001

THRUST REVERSER DESCRIPTION (EA) (3)

Tertiary Lock System

Purpose

The Tertiary Lock System (TLS) locks the thrust reverser in the stowed position. It is capable of preventing inadvertent deployment even if the PDU is rotating and all other locks are failed.

Location

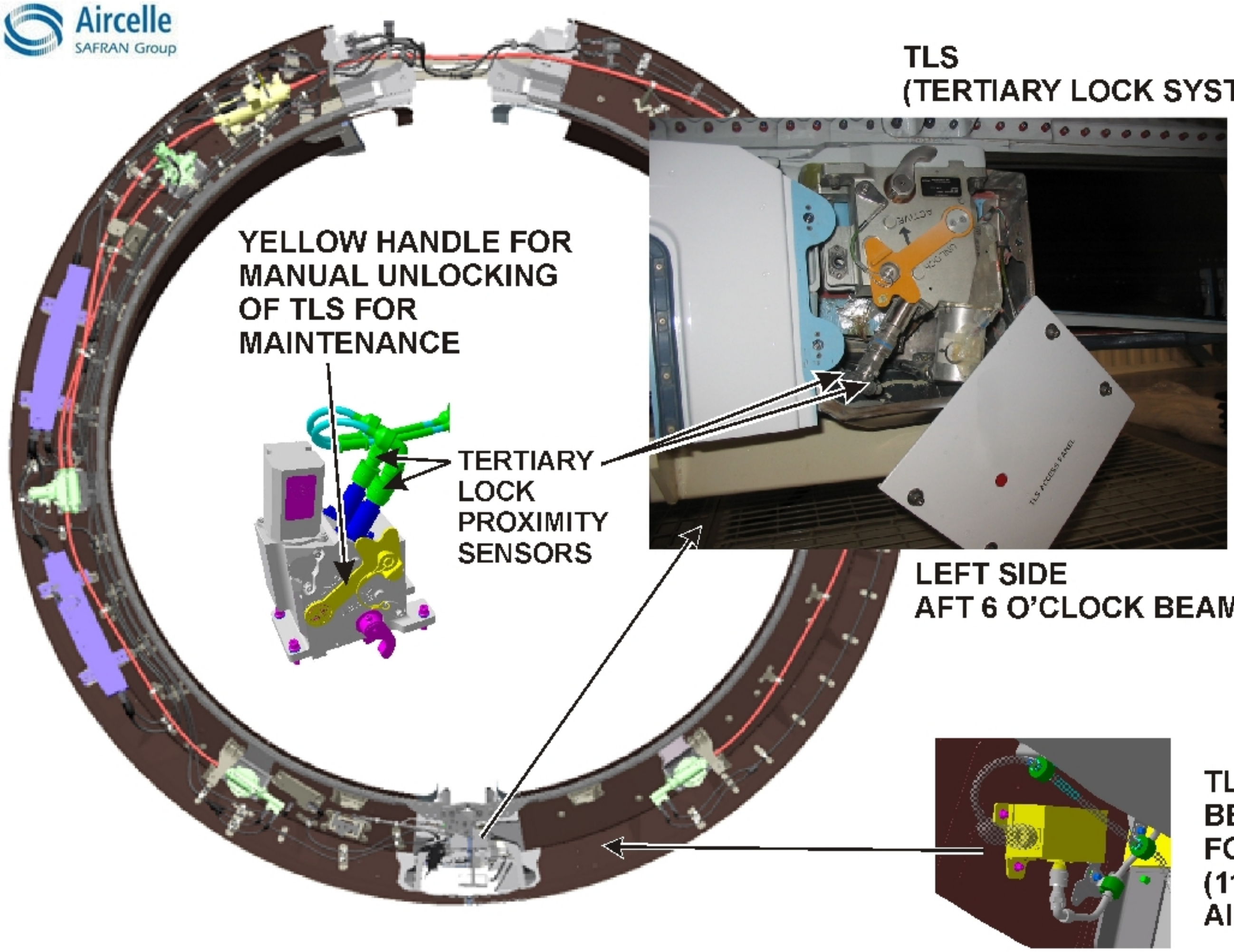
The access to the TLS is through a panel mounted on the left rear beam at 6 o'clock
The Tertiary Lock System Power Unit (TLSPU) is mounted on the backside of the left forward frame at 6 o'clock.

Components

TLS
TLSPU.

Description and Operation

The TLS is unlocked to allow reverse deployment.
It is controlled and powered directly from the aircraft (115 VAC - 1 phase). It is an independent line of defense.
Power is supplied from the aircraft to TLS through the TLSPU.
Two sensors are mounted on the TLS to monitor TLS status, locked or unlocked.
The TLSPU is visible when the transcowls are deployed.
The yellow handle on the unit, unlocks the tertiary lock for manual deployment. The quick release pin keeps the handle in the unlock/lock position.
There is a red pop-out indicator on the access panel, which becomes visible when the lever is in the unlock position
No servicing is required.



TLS
(TERTIARY LOCK SYSTEM)

YELLOW HANDLE FOR MANUAL UNLOCKING OF TLS FOR MAINTENANCE

TERTIARY LOCK PROXIMITY SENSORS

LEFT SIDE
AFT 6 O'CLOCK BEAM

TLSPU -
BEHIND THE LEFT FORWARD FRAME
(115 VAC - 1 PHASE AIRCRAFT POWER)

CTC70087.20081120

TERTIARY LOCK SYSTEM - PURPOSE ... DESCRIPTION AND OPERATION

THRUST REVERSER DESCRIPTION (EA) (3)

Thrust Reverser Power Unit

Purpose

The Thrust Reverser Power Unit (TRPU), with a command from the ETRAC, provides the necessary electrical power for the operation of the PLS and PDU brake and motor.

Location

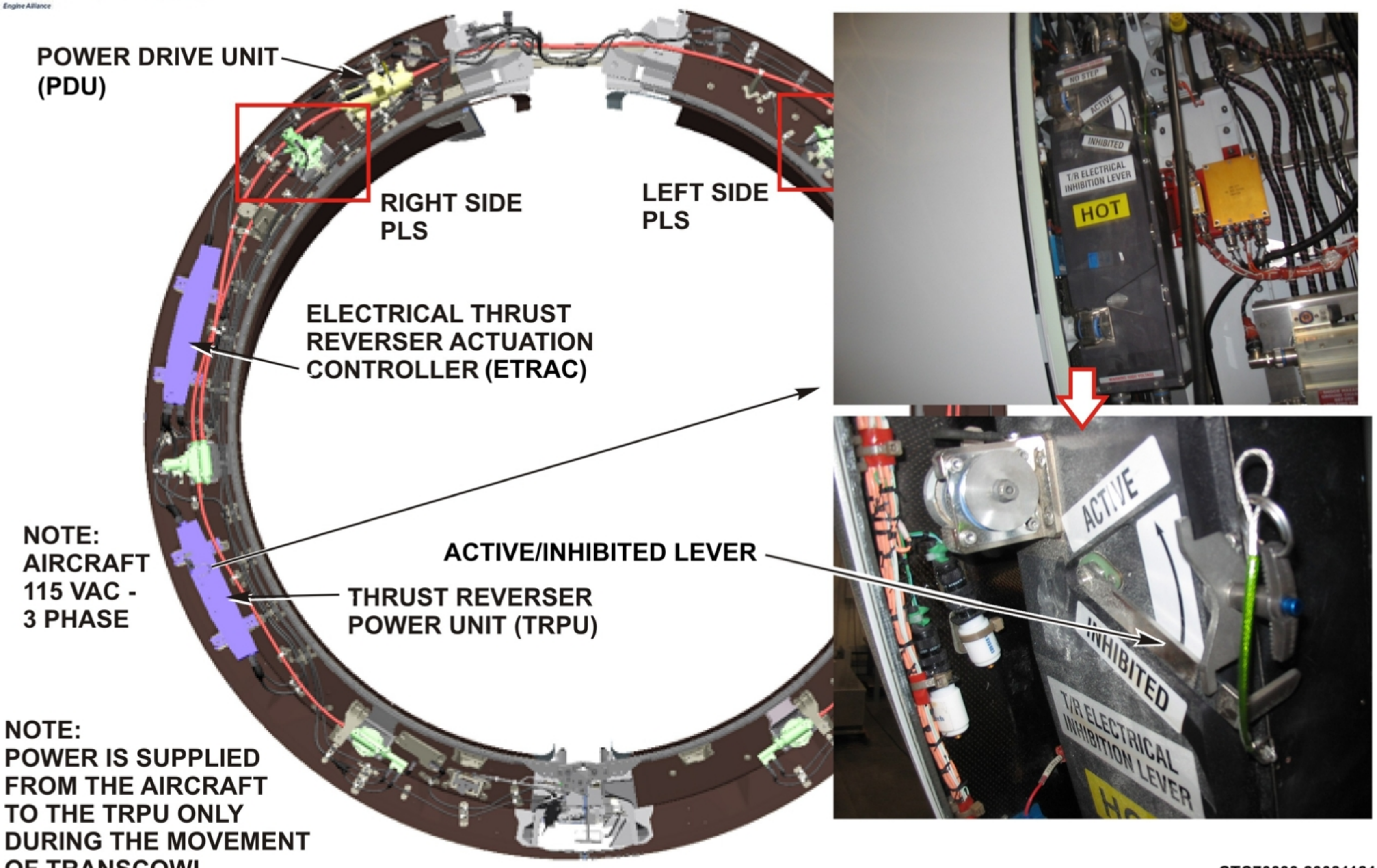
The TRPU is damper mounted on the right forward frame at 4 o'clock.

LRUs

Thrust reverser power unit.

Description and Operation

The TRPU is controlled and monitored by the ETRAC.
The TRPU filters and rectifies aircraft power (115VAC - 3 phase).
A power inhibition lever is located on the TRPU for ground maintenance safety and for in-flight ETRAS â electrical inhibition.
The lever is spring loaded to the inhibited position.
A ball pin secures the position of the lever
Power is supplied from the aircraft to the TRPU only during transcowl movement.


POWER DRIVE UNIT (PDU)
RIGHT SIDE PLS
LEFT SIDE PLS
ELECTRICAL THRUST REVERSER ACTUATION CONTROLLER (ETRAC)
ACTIVE/INHIBITED LEVER
THRUST REVERSER POWER UNIT (TRPU)
NO STEP
ACTIVE
INHIBITED
T/R ELECTRICAL INHIBITION LEVER
HOT

NOTE:
AIRCRAFT
115 VAC -
3 PHASE

NOTE:
POWER IS SUPPLIED
FROM THE AIRCRAFT
TO THE TRPU ONLY
DURING THE MOVEMENT
OF TRANSCOWL

CTC70099.20081121

THRUST REVERSER POWER UNIT - PURPOSE ... DESCRIPTION AND OPERATION

THRUST REVERSER DESCRIPTION (EA) (3)

Electrical Thrust Reverser Actuation Controller

Purpose

The Electrical Thrust Reverser Actuation Controller (ETRAC) controls and monitors the Thrust Reverser Power Unit (TRPU).
Commands the left primary lock system and the power drive unit

Location

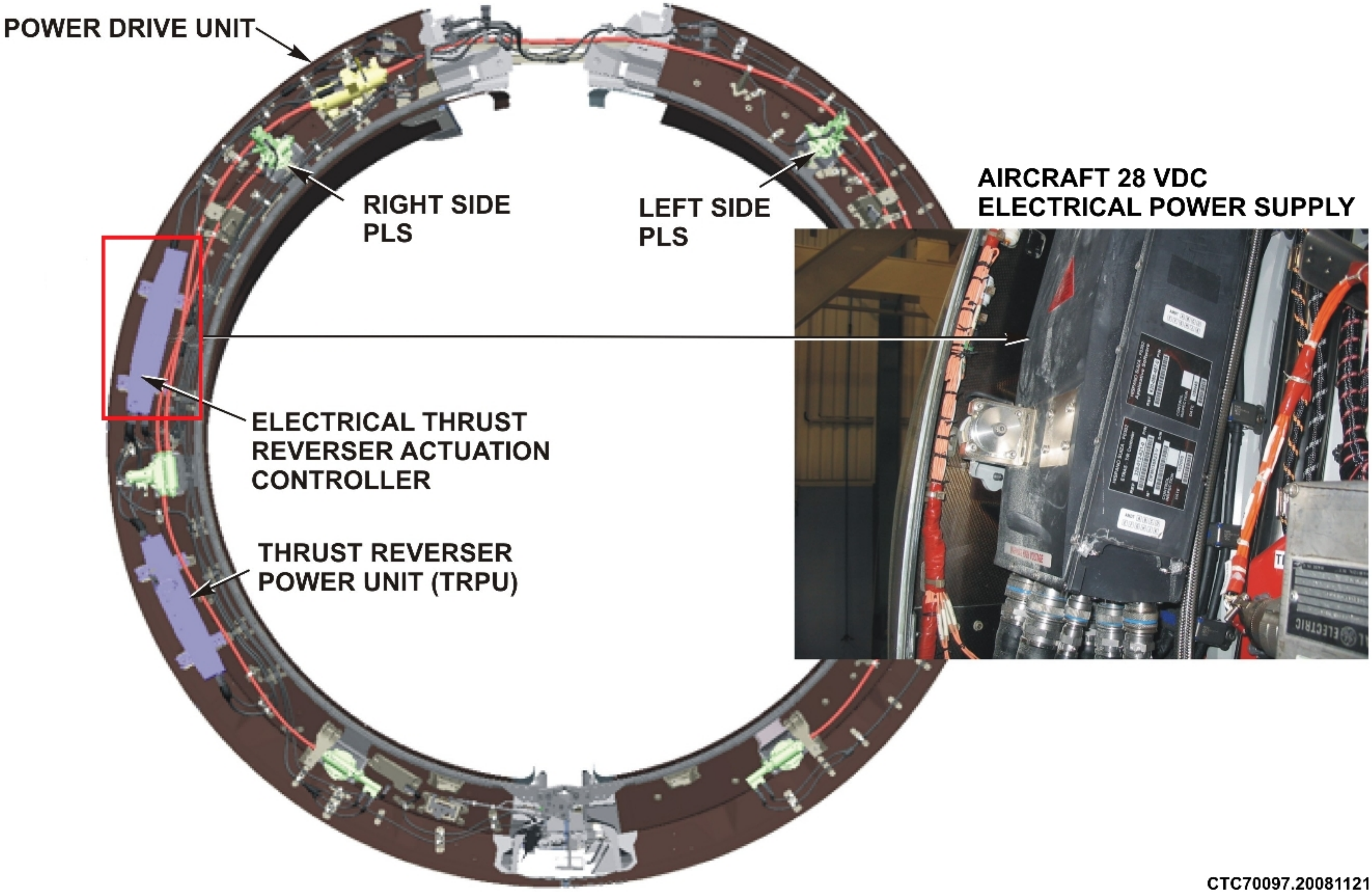
The ETRAC is damper mounted on the forward frame at 2:30.

LRUs

Electrical thrust reverser actuation controller.

Description and Operation

The ETRAC digitally interfaces to the EEC and provides control of the position of the sleeves.
The aircraft supplies the ETRAC with direct current (28 VDC) for ETRAC operation and TRPU monitoring.


POWER DRIVE UNIT
RIGHT SIDE PLS
LEFT SIDE PLS
AIRCRAFT 28 VDC ELECTRICAL POWER SUPPLY
ELECTRICAL THRUST REVERSER ACTUATION CONTROLLER
THRUST REVERSER POWER UNIT (TRPU)

CTC70097.20081121

ELECTRICAL THRUST REVERSER ACTUATION CONTROLLER - PURPOSE ... DESCRIPTION AND OPERATION

THRUST REVERSER DESCRIPTION (EA) (3)

Power Drive Unit

Purpose

The Power Drive Unit (PDU) distributes mechanical power to the middle ballscrew actuators.

Location

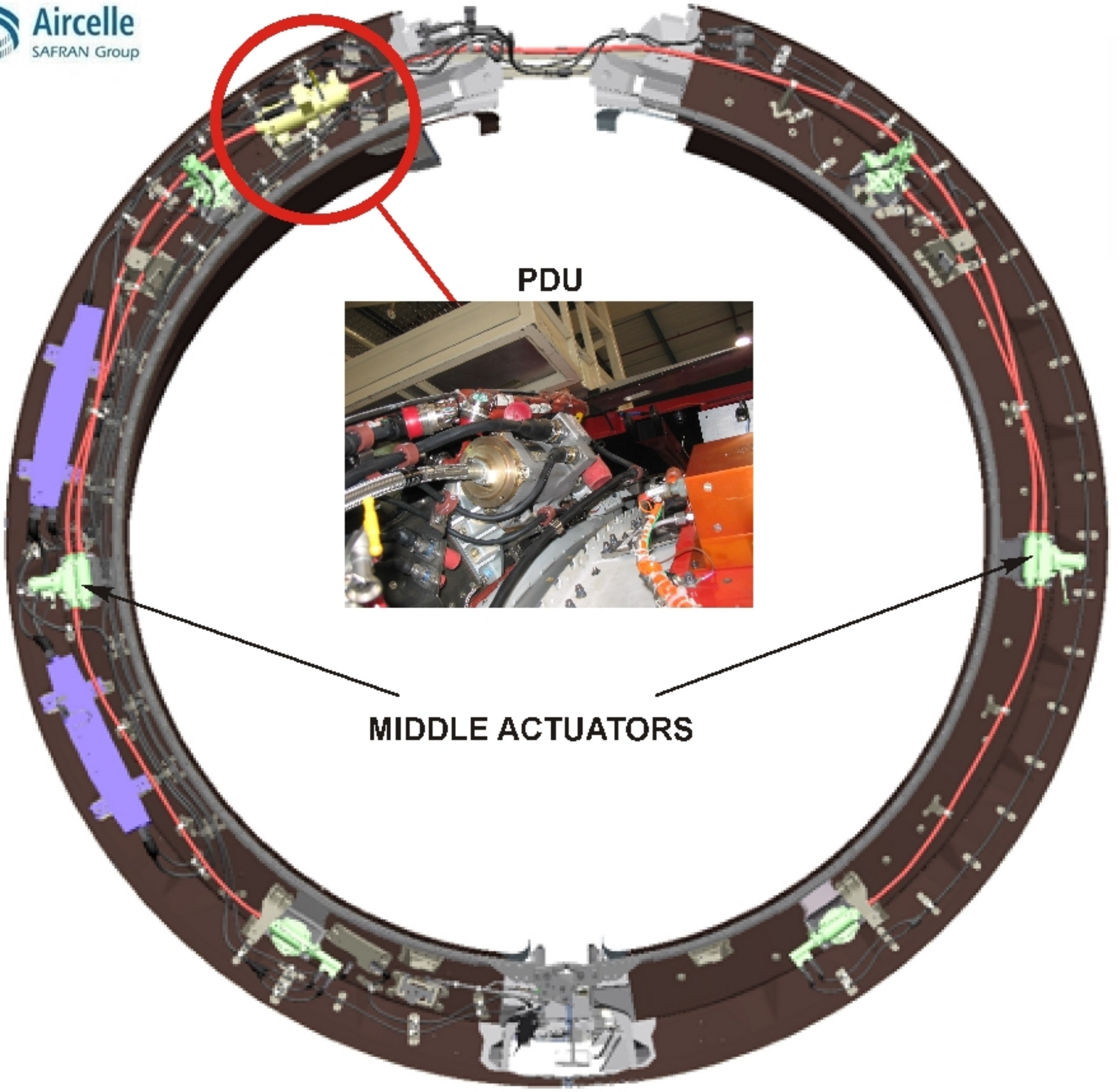
The PDU is on right forward frame at 12:30 o'clock.

LRUs

PDU

Description and Operation

The PDU power is transferred to the center actuators through two flexshafts, and then from the center actuators to the upper and lower actuators through four flexshafts.
The PDU contains the motor and the brake.
The brake provides overspeed protection in case of loss of motor speed control.


PDU
MIDDLE ACTUATORS
CTC34723.20081121

POWER DRIVE UNIT - PURPOSE ... DESCRIPTION AND OPERATION

THRUST REVERSER DESCRIPTION (EA) (3)

Actuators and Flexshafts

Purpose

The actuators deployed and stowed the transcowl, provide position feedback to the EEC and ETRAC and lock the thrust reverser transcowls when stowed.
The flexshafts transfer the mechanical power from the PDU to the actuators

Location

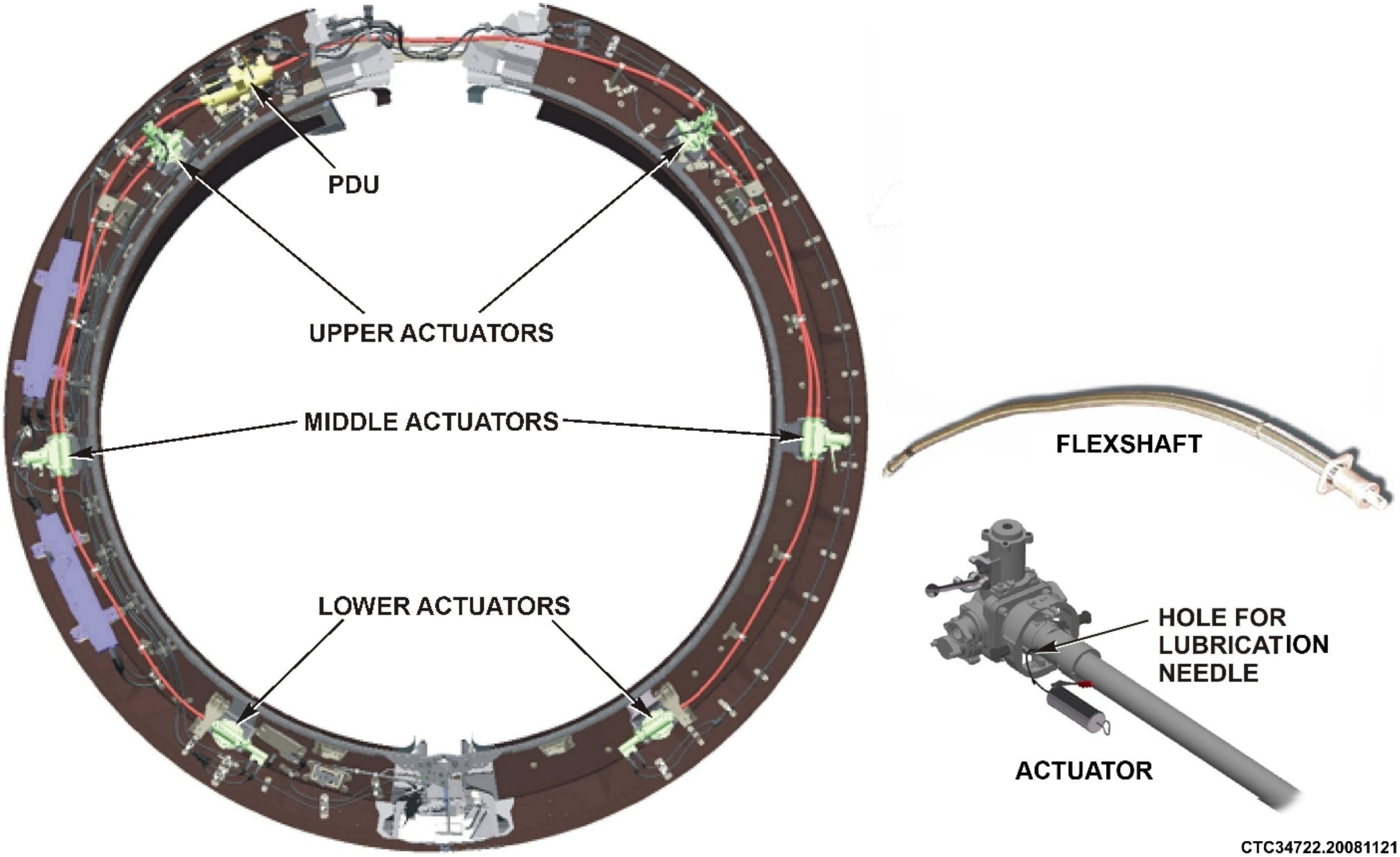
Actuators are mounted on the forward frame at 8, 9 10, 2, 3, and 4 o'clock.
The flexshafts are statically mounted on the forward frame with brackets

LRUs

6 Flexshafts,
6 Actuators.

Description and Operation

Flexshafts convey mechanical power from the PDU output to a gear set mounted on the center actuators
- 4 flexshafts, 2 on the left and 2 on the right nacelle distribute mechanical power form each center actuator the corresponding upper and lower
actuators on each transcowl
- The 2 center actuators incorporate a Manual Drive Unit (MDU)
- The 2 upper actuators incorporate the Primary Lock System (PLS)
- The 2 lower actuators incorporates resolvers
- There are 2 holes on each actuator for servicing.


PDU
UPPER ACTUATORS
MIDDLE ACTUATORS
LOWER ACTUATORS
FLEXSHAFT
HOLE FOR LUBRICATION NEEDLE
ACTUATOR
CTC34722.20081121

ACTUATORS AND FLEXSHAFTS - PURPOSE ... DESCRIPTION AND OPERATION

THRUST REVERSER DESCRIPTION (EA) (3)

Resolvers

Purpose

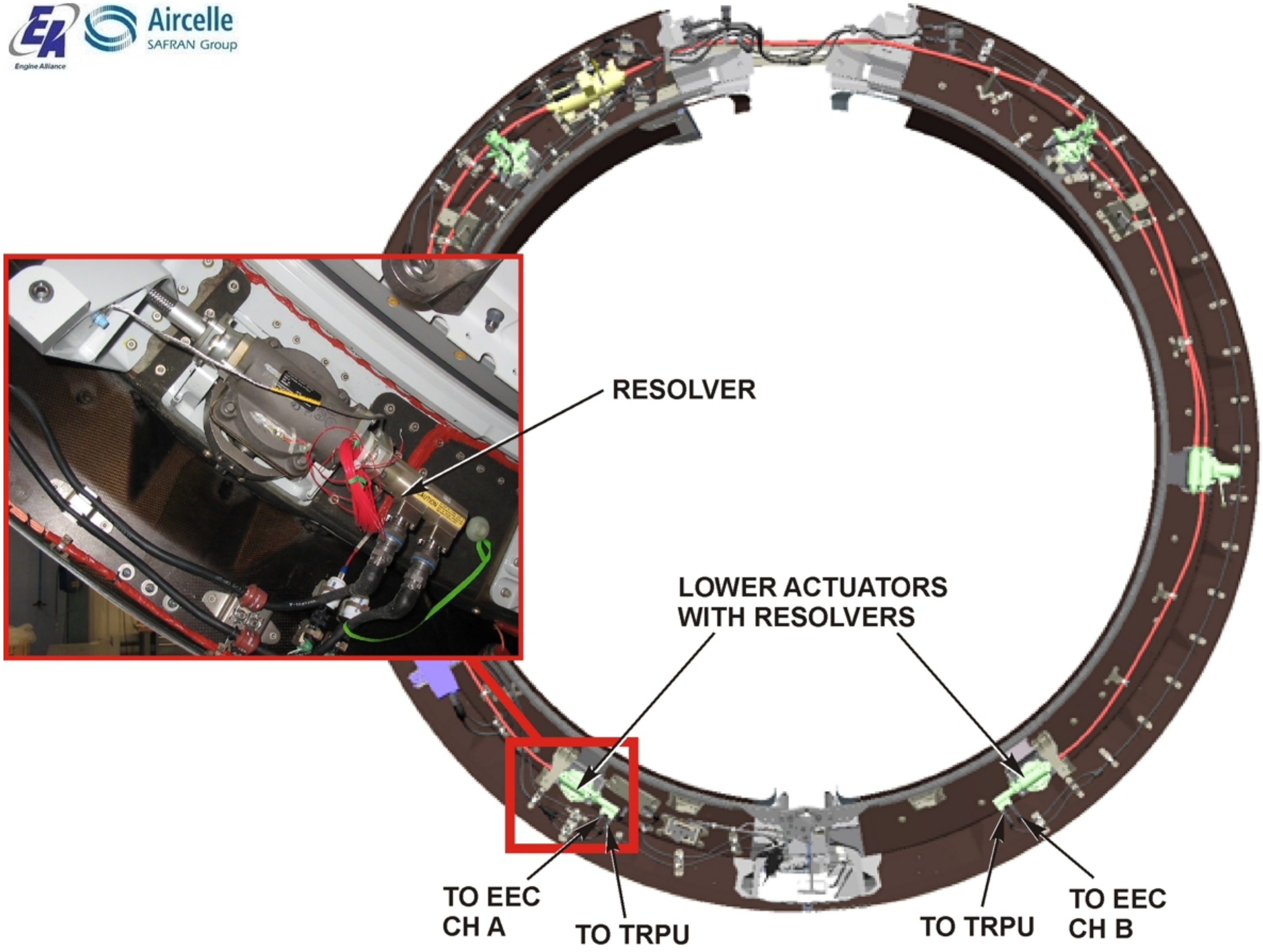
Two resolvers on each actuator monitor the position of the transcowls and send the signal to the ETRAC and to the EEC.

Location

The resolvers are mounted on the lower actuators.

Description and Operation

One resolver signal is provided to the ETRAC for electrical motor control.
One resolver signal is provided to the corresponding EEC channel for monitoring.
- Left side actuator resolver to Channel B
- Right side actuator resolver to Channel A


RESOLVER
LOWER ACTUATORS WITH RESOLVERS
TO EEC CH A
TO TRPU
TO TRPU
TO EEC CH B

CTC70061.20081121

RESOLVERS - PURPOSE ... DESCRIPTION AND OPERATION

THRUST REVERSER DESCRIPTION (EA) (3)

Manual Drive Unit (MDU)

Purpose

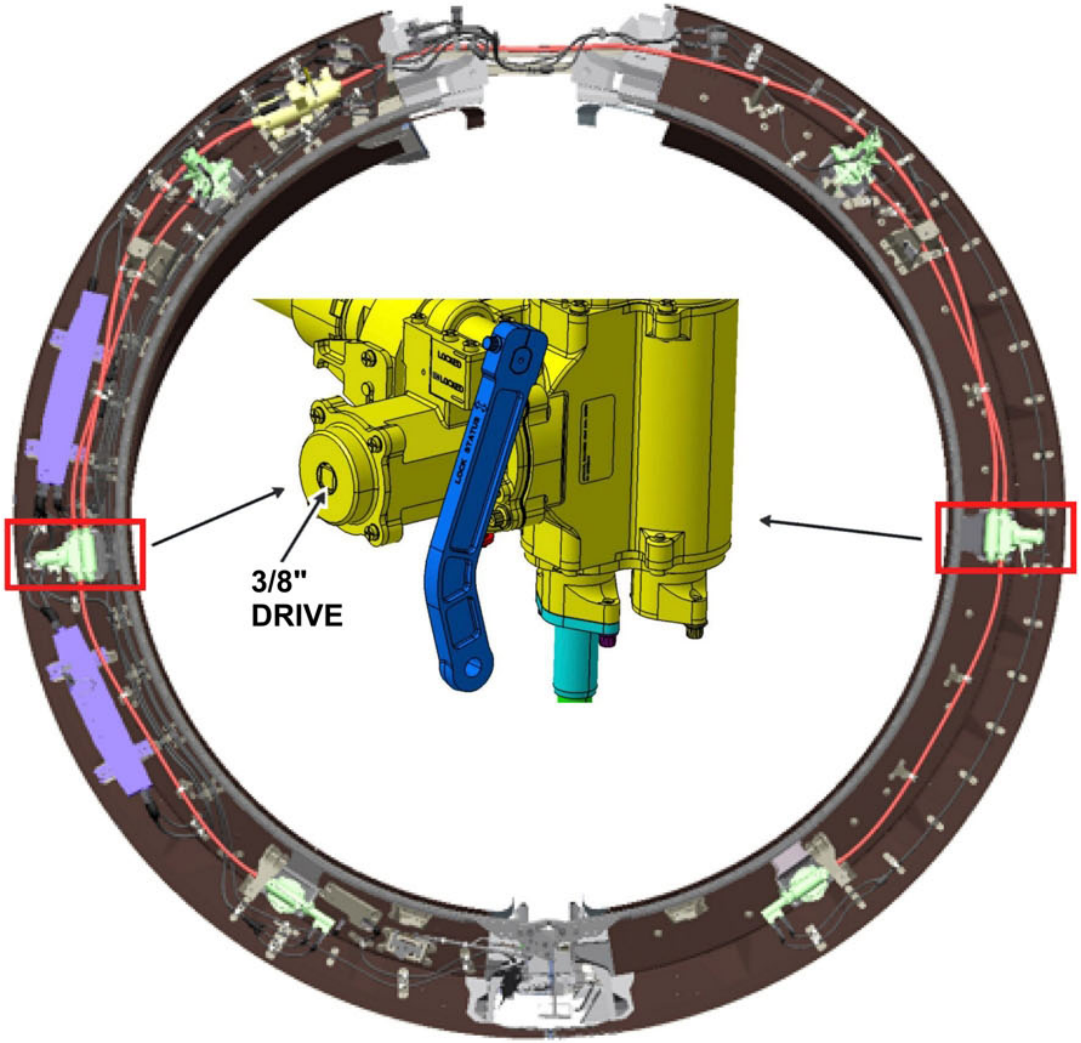
Manual drive units provide manual deployment and stowage of the transcowls for maintenance.

Location

A manual drive unit is located on each middle actuator.

Description and Operation

On each MDU, there is a 3/8" square drive to put a power wrench or a speed wrench.
On each MDU, a handle provides locking of the transcowls.
If the lock handle is in the locked position, it is returned to the active position automatically when the fan cowl doors are closed. A stiffener on the fan cowl door contacts the lock handle when the cowl door is closed.


3/8"
DRIVE
LOCKED
UNLOCKED
LOCK STATUS

CTC70096.20081121

MANUAL DRIVE UNIT (MDU) - PURPOSE ... DESCRIPTION AND OPERATION

THRUST REVERSER DESCRIPTION (EA) (3)

Thrust Reverser Deactivation for Maintenance

Purpose

For any maintenance operation, it is necessary to deactivate the thrust reverser power unit (TRPU).
It is an electrical deactivation of the complete thrust reverser system

Location

The deactivation lever is located on the TRPU, on the forward frame at 4 o'clock.

Description and Operation

The TRPU has a lever that can be set in two positions:
- INHIBITED,
- ACTIVE.

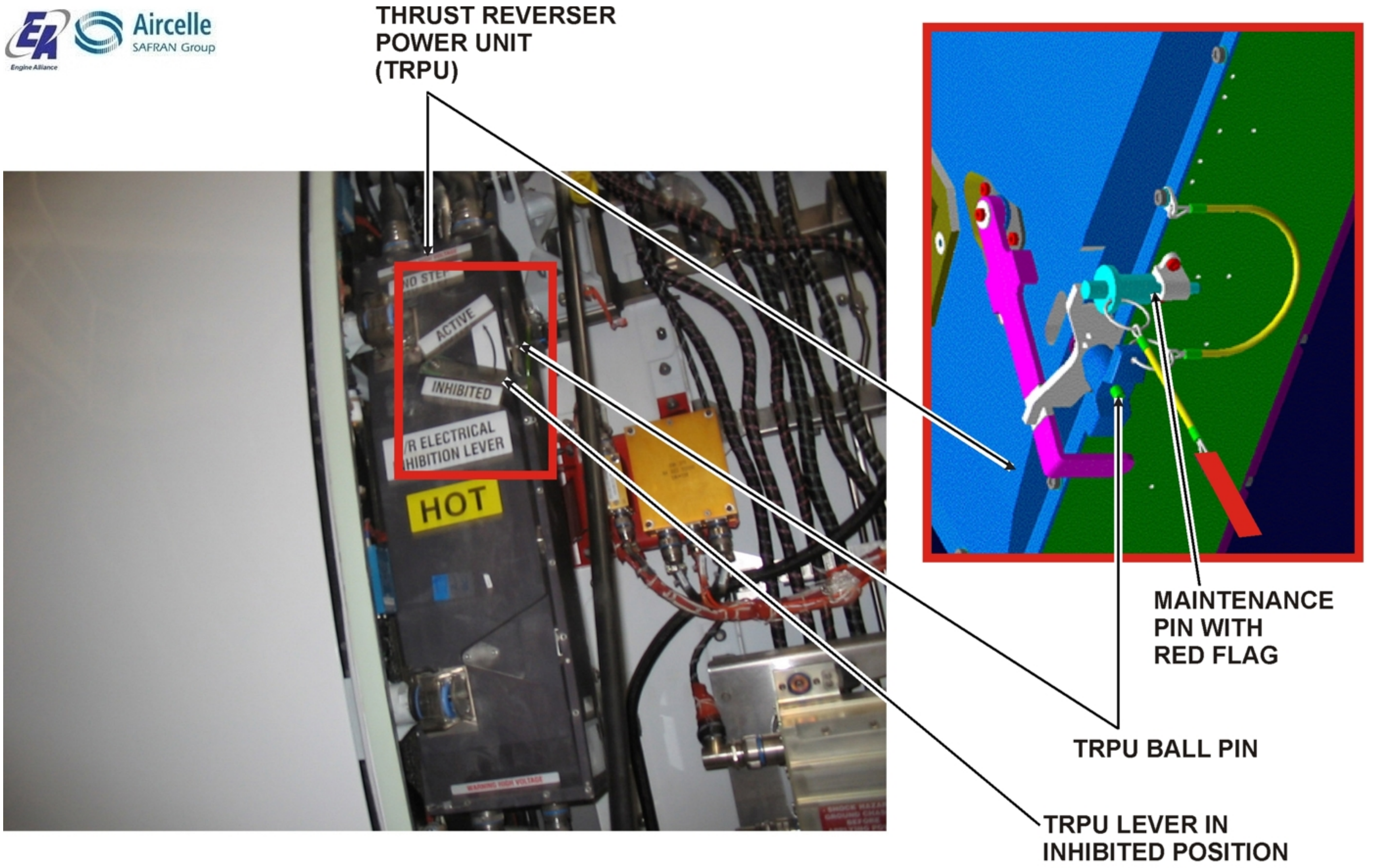
The lever can be secure in either position by a ball pin
The ball pin is attached to the TRPU with a lanyard.
After the maintenance operation, the thrust reverser must be activated

Procedure

Deactivation for maintenance:
- Remove the ball pin,

NOTE: The lever goes automatically to the INHIBITED position.
- Install the ball pin to secure the lever in the INHIBITED position,
- Install the maintenance pin with the red flag.

Activation after maintenance:
- Remove the maintenance pin with the red flag,
- Remove the ball pin,
- Move the lever to the ACTIVE position,
- Maintain the lever in ACTIVE position and install the ball pin.


THRUST REVERSER POWER UNIT (TRPU)
NO STEP
ACTIVE
INHIBITED
/R ELECTRICAL
HIBITION LEVER
HOT
MAINTENANCE PIN WITH RED FLAG
TRPU BALL PIN
TRPU LEVER IN INHIBITED POSITION

CTC70100.20081121

THRUST REVERSER DEACTIVATION FOR MAINTENANCE - PURPOSE ... PROCEDURE

THRUST REVERSER DESCRIPTION (EA) (3)

Thrust Reverser Deactivation for Flight

Purpose

The thrust reverser must be deactivated for flight in case of failure of the thrust reverser system
It is a mechanical and electrical (TRPU) deactivation of the thrust reverser.

Location

The access to the mechanical deactivation system is through a panel located on the right rear 6 o'clock beam.
The TRPU is located on the thrust reverser forward frame at 4 o'clock.

Description and Operation

The mechanical deactivation system has a lever and a pin that can be set in two positions:
- INHIBITED
- ACTIVE

The lever can be secure in either position by a ball pin, which is attached to the beam with a lanyard
There is a red pop-out indicator on the access panel, which becomes visible when the lever is in the inhibited position (thrust reverser locked).
For electrical deactivation TRPU lever must be set to the inhibited position.
When the thrust reverser is ready to operate, the thrust reverser must be reactivated for flight.
Note: The mechanical deactivation access panel is marked on the inner side to indicate the inhibited or active position of the mechanical deactivation pin.

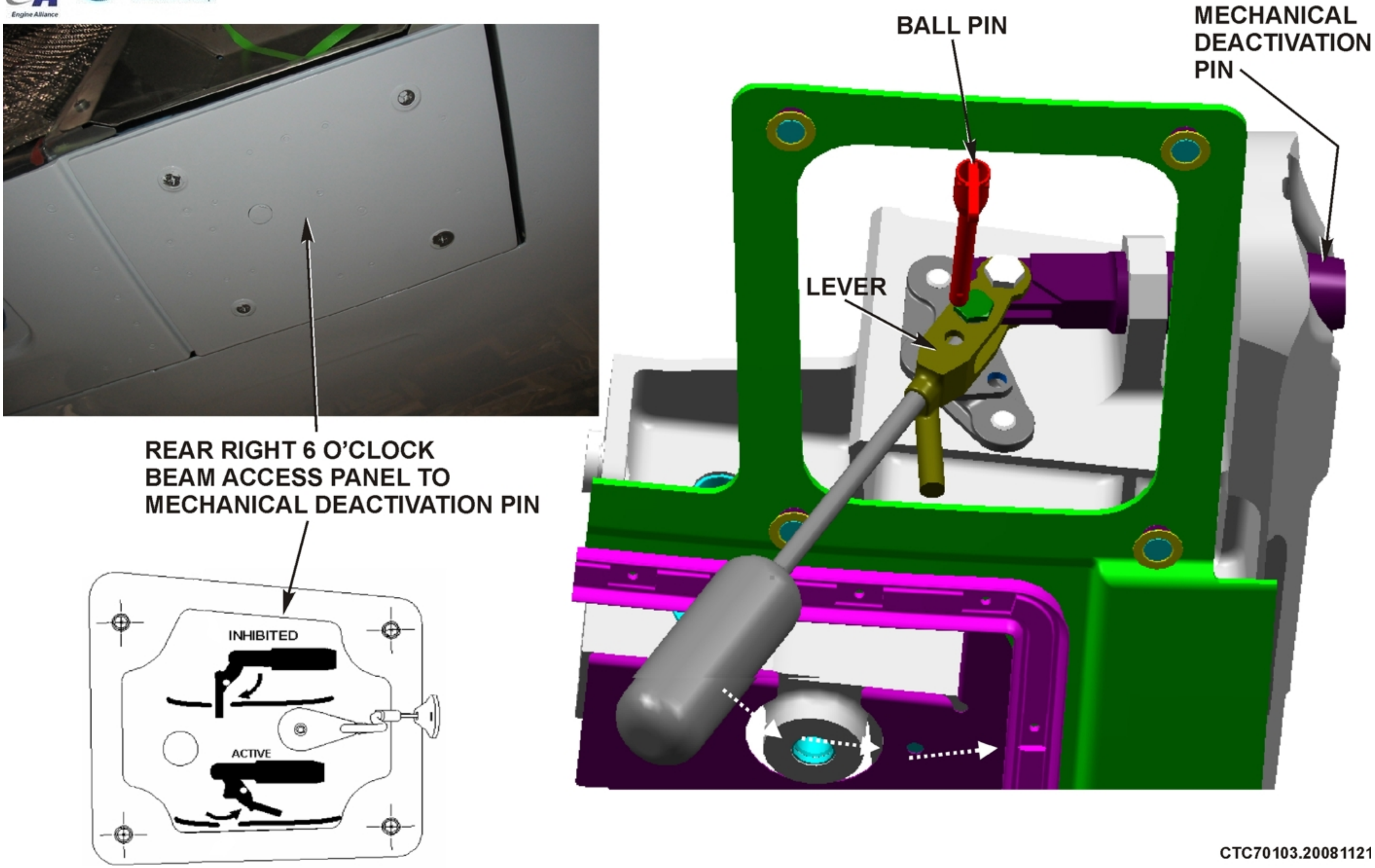
Procedure

Deactivation for flight:
Electrical
- Deactivate the TRPU

Mechanical
- Remove the access panel (4 captive screws)
- Remove the ball pin,
- Use a screwdriver to move the lever and the mechanical deactivation pin in the INHIBITED position,
- Install the ball pin,
- Install the access panel.
- Red pop-out visible

Activation after flight:
Electrical
- Activate the TRPU

Mechanical
- Remove the access panel,
- Remove the ball pin,
- Use a screwdriver to move the lever and the mechanical deactivation pin in the ACTIVE position,
- Install the ball pin,
- Install the access panel.
- Red pop-out not visible.


BALL PIN
MECHANICAL DEACTIVATION PIN
LEVER
REAR RIGHT 6 O'CLOCK BEAM ACCESS PANEL TO MECHANICAL DEACTIVATION PIN
INHIBITED
ACTIVE
CTC70103.20081121

THRUST REVERSER DEACTIVATION FOR FLIGHT - PURPOSE ... PROCEDURE

THRUST REVERSER DESCRIPTION (EA) (3)

Primary Lock System Unlocking/Activation

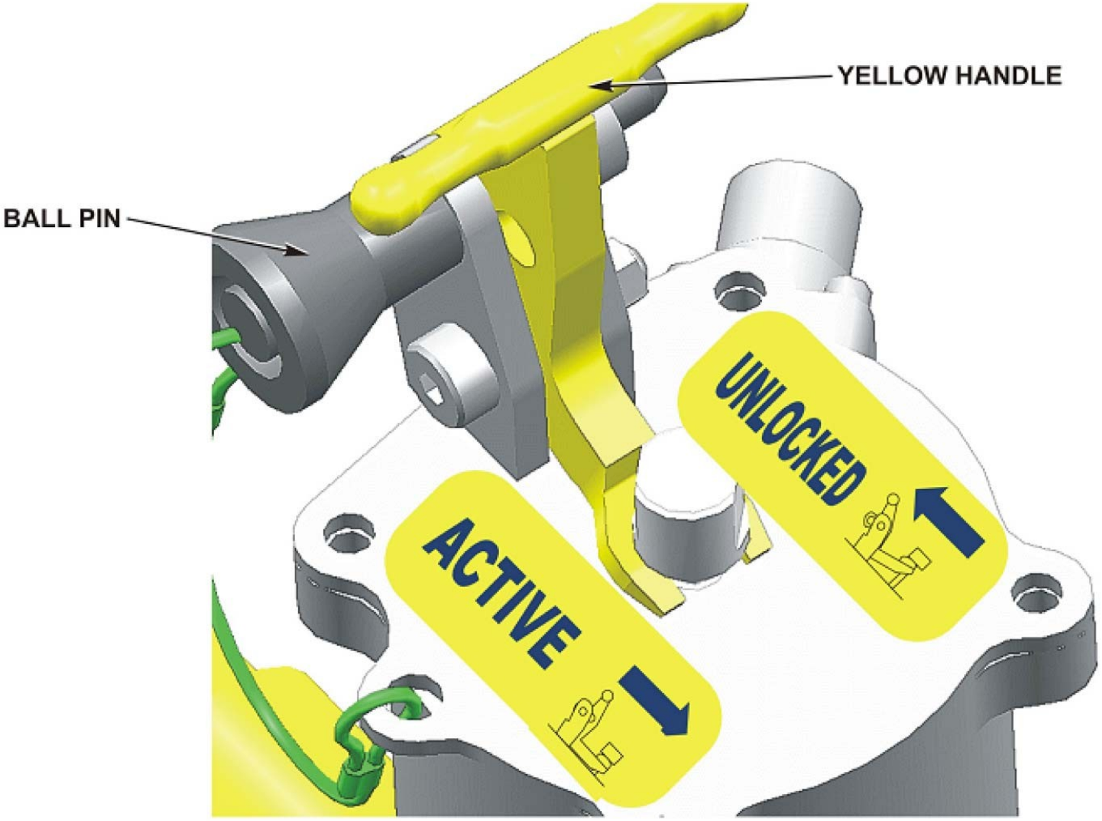
Purpose

These tasks are necessary to manually deploy or stow the thrust reverser transcowls for maintenance.

Procedure

Primary Lock System Unlocking:
- Remove the ball pin,
- Pull the yellow handle to the UNLOCKED position,
- Install the maintenance ball pin.

Primary Lock System Activation:
- Remove the maintenance ball pin,
- Push the yellow handle to the ACTIVE position,
- Install the ball pin.


YELLOW HANDLE
BALL PIN
UNLOCKED
ACTIVE

CTC70102.20060818

PRIMARY LOCK SYSTEM UNLOCKING/ACTIVATION - PURPOSE & PROCEDURE

THRUST REVERSER DESCRIPTION (EA) (3)

Tertiary Lock System Unlocking/Activation

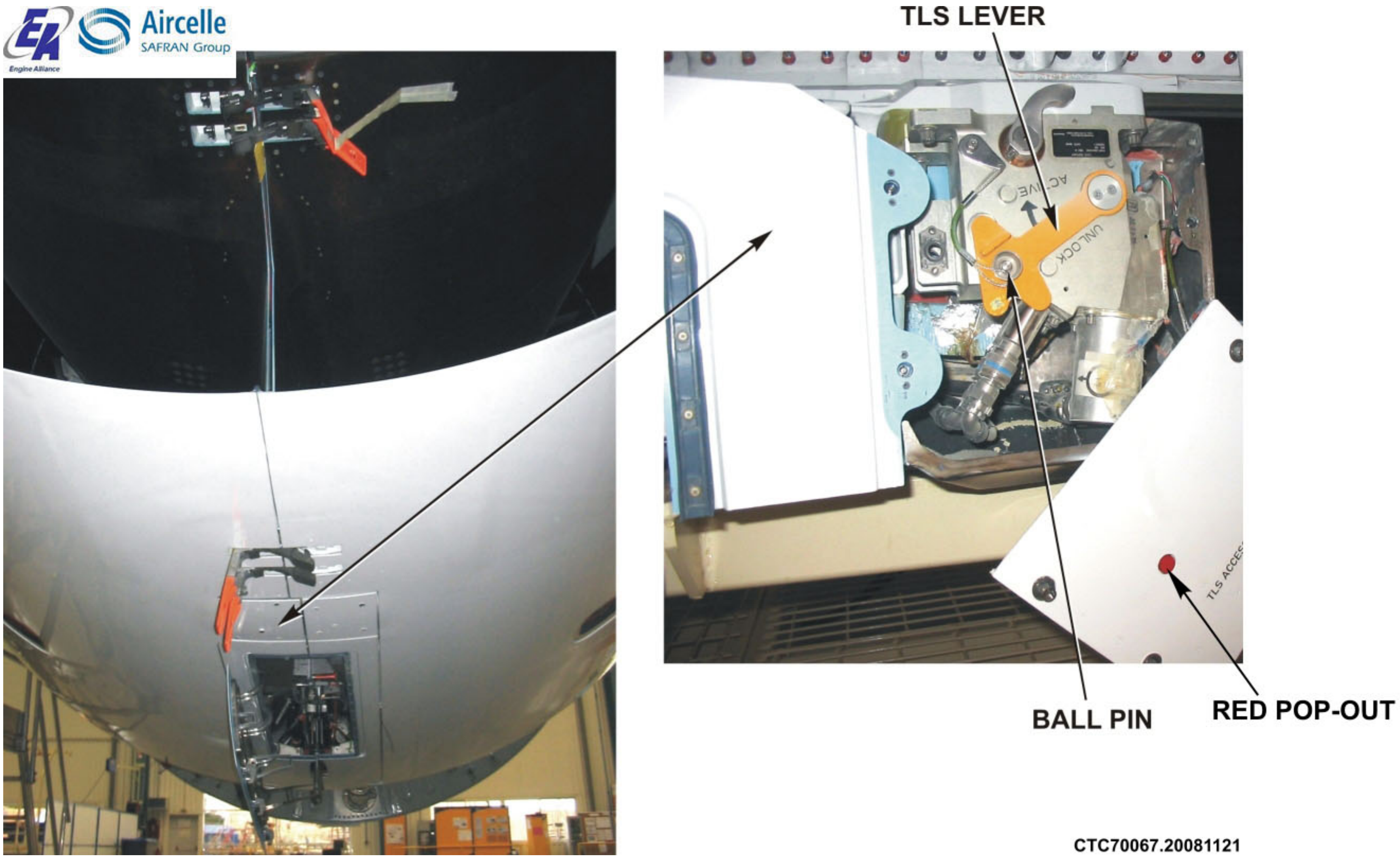
Purpose

These tasks are necessary to manually deploy or stow the thrust reverser transcowls for maintenance.

Procedure

Tertiary lock system unlocking:
- Remove the access panel,
- Remove the ball pin,
- Rotate the lever from the ACTIVE position to the UNLOCK position,
- Install the ball pin.
- Install the access panel
- Red pop-out visible

Tertiary lock system activation:
- Remove the access panel
- Remove the ball pin,
- Rotate the lever from the UNLOCK position to the ACTIVE position,
- Install the ball pin.
- Install the access panel
- Red pop-out not visible


TLS LEVER
ACTIVE
UNLOCK
TLS ACCES
BALL PIN
RED POP-OUT
CTC70067.20081121

TERTIARY LOCK SYSTEM UNLOCKING/ACTIVATION - PURPOSE & PROCEDURE

THRUST REVERSER DESCRIPTION (EA) (3)

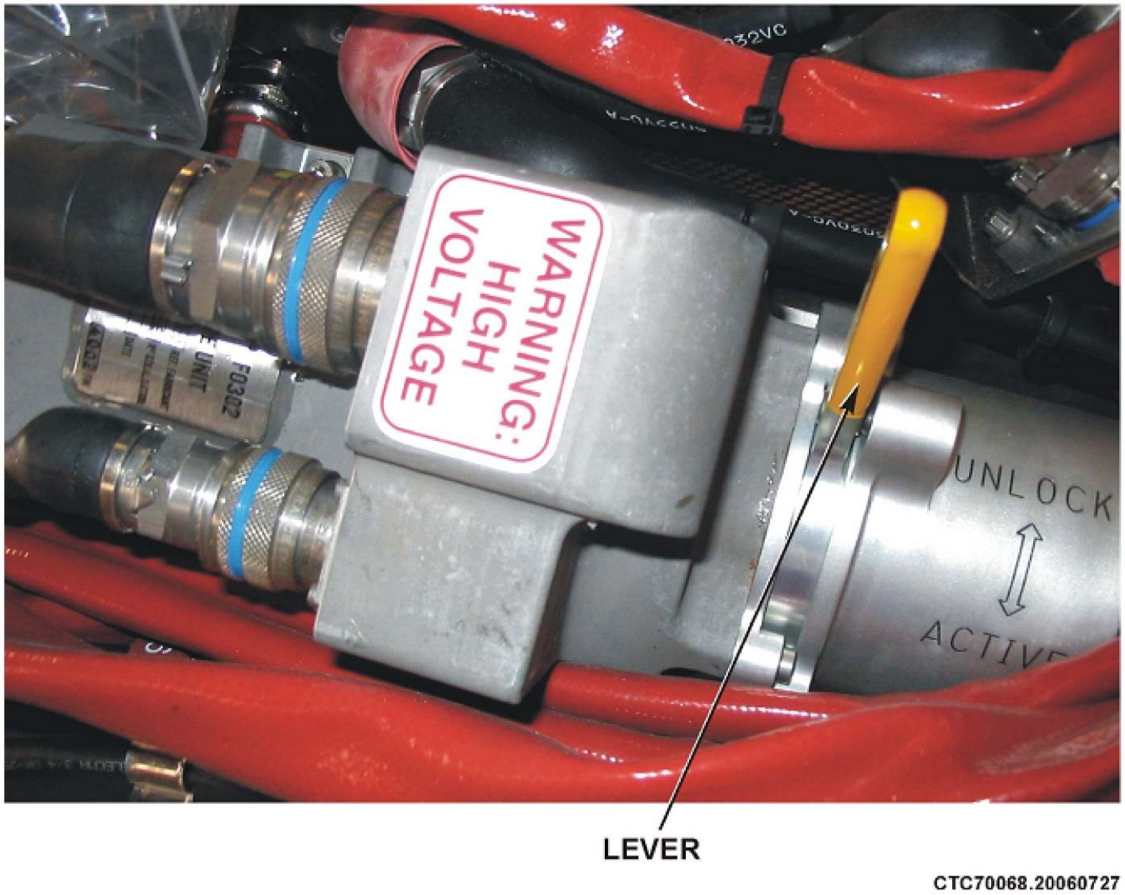
Power Drive Unit Unlocking/Activation

Purpose

These tasks are necessary to manually deploy or stow the thrust reverser transcowls for maintenance.

Procedure

Power drive unit unlocking:
- Rotate the lever from the ACTIVE position to the UNLOCK position.
Power Drive Unit Activation:
- Rotate the lever from the UNLOCK position to the ACTIVE position.


WARNING: HIGH VOLTAGE
UNLOCK
ACTIVE
LEVER
CTC70068.20060727

POWER DRIVE UNIT UNLOCKING/ACTIVATION - PURPOSE & PROCEDURE

THRUST REVERSER DESCRIPTION (EA) (3)

Transcowls Manual Deployment/Stowage

Purpose

For maintenance operation such as inspection, removal/installation of cascades, blocker doors, it is necessary to manually deploy/stow the transcowls.

Location

The Manual Drive Unit (MDU) is located on the middle actuator.

Deployment of the Transcowls

Deployment of the transcowls:

WARNING: Check that the latches L5-1 and L5-2 are properly locked. These latches link the two transcowls together.

CAUTION: Do not lock or activate any component when the thrust reverser transcowl is deployed.
Do not work on a deployed thrust reverser transcowl without locking the manual drive unit.

- Open the fan cowl doors,
- Deactivate the thrust reverser power unit,
- Unlock the two primary lock systems,
- Unlock the tertiary lock system,
- Unlock the power drive unit brake,
- Make sure that the two MDU lock levers are in the UNLOCKED position,
- Use the MDU to deploy the transcowl,
- Use a 3/8 inch speed wrench is recommended,
- Use of a pneumatic drill is also possible,
- The torque to apply to the MDU drive port is 4 N.m (35.4 lbf.in),
- Lock the two MDU lock levers by putting the levers in the LOCKED position.

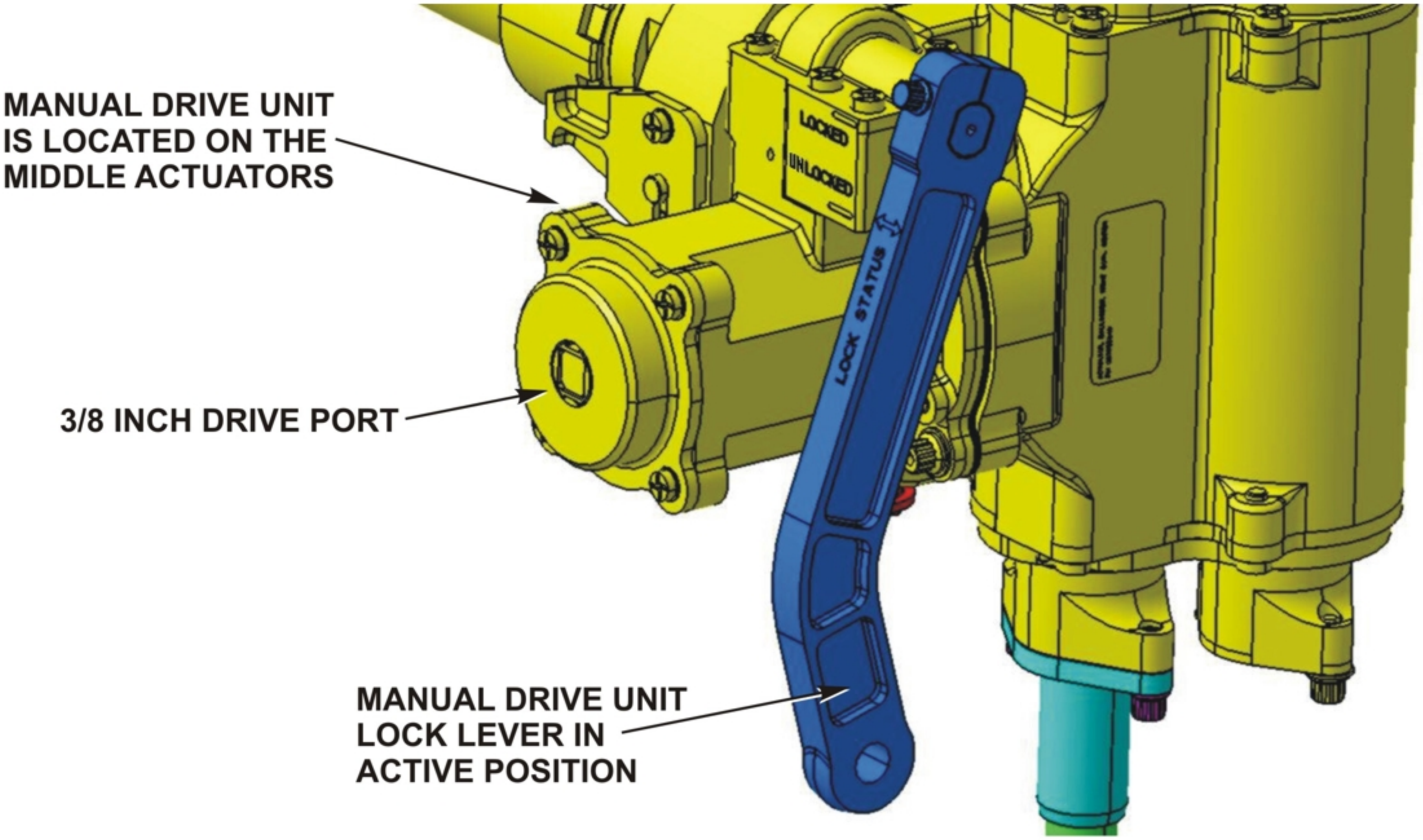
CAUTION: Do not apply a torque greater than 15 N.m. (135 in.lbs.) to the manual drive unit for manual deployment or stowage.

CAUTION: When the transcowl is deployed, lock the sleeve manual drive unit lock before doing any maintenance operation.

Stowage of the transcowls

Use the MDU to stow the transcowl,
Activate the power drive unit brake,
Lock the tertiary lock system,
Lock the two primary lock systems,
Activate the thrust reverser power unit,
Close the fan cowl doors.

CAUTION: After the full stowage of a transcowl, do not forget to check that the manual drive unit lock lever is in the unlocked position before doing any electrical cycles.


MANUAL DRIVE UNIT IS LOCATED ON THE MIDDLE ACTUATORS
LOCKED
UNLOCKED
LOCK STATUS
3/8 INCH DRIVE PORT
MANUAL DRIVE UNIT LOCK LEVER IN ACTIVE POSITION

CTC70101.20060818

TRANSCOWLS MANUAL DEPLOYMENT/STOWAGE - PURPOSE ... STOWAGE OF THE TRANSCOWLS

THRUST REVERSER CONTROL DESCRIPTION (3)

General

The A380 GP7200 Electrical Thrust Reverser Actuation System (ETRAS) is an electro-mechanical system, which lets the translating cowls of engines 2 & 3 be deployed and stowed in response to electrical commands from the Electronic Engine Control (EEC) and from the aircraft interfaces.
The thrust reverser assembly is installed at the aft part of the nacelle, only on the aircraft inboard engines (No. 2 & 3).
The assembly is a conventional fixed cascade translating cowl blocker door type. It is composed of two halves that make a duct around the engine.
Each halve has a fixed structure used as a support for the cascades, the actuation system and the translating cowl.
Both engine-translating cowls are mechanically linked and slide on the thrust reverser upper and lower tracks.
The thrust reverser halves open at the 12 o'clock hinge beam to give access to the engine during maintenance operations.
The ETRAS carries out the following functions:
- deployment of the thrust reverser translating cowls when the deploy command is set,
- stowage of the thrust reverser translating cowls when the stow command is set,
- avoidance of inadvertent deployment of the thrust reversers,
- manual deployment and stowage of the translating cowls for maintenance,
- manual inhibition and deactivation of the translating cowls for maintenance.

Architecture

The deploy command has three independent electrical command lines upon a reverser thrust selection of the throttle control assembly:
- aircraft 115 VAC power supply commanded by the flight/ground control PRIM to the tertiary lock system,
- aircraft 115 VAC from Engine Interface Power Management (EIPM) to Thrust Reverser Power Unit (TRPU),
- electrical command from EEC to Electronic Thrust Reverser Actuation Controller (ETRAC).

For ETRAS monitoring, fault reporting and BITE test, the EEC communicates with the On-board Maintenance System (OMS) and Control and Display System (CDS) via Avionics Data Communication Network (ADCN).
For maintenance equipment, a thrust reverser operational test (deploy/stow) is available on the OMS.
The ETRAS is basically composed of:
- ETRAC,
- TRPU,
- Power Drive Unit (PDU) electrical motor,
- 6 ball screw actuators mechanically driven through a synchronizing flexible shaft power train system from the PDU.

Actuation

The ETRAS operates in normal mode, when the following initial conditions are met:
- aircraft on the ground,
- engines are running,
- and Throttle Lever in Reverse thrust position.

The Electrical Power is supplied from the aircraft to the TRPU.
The TRPU supplies electrical power through the ETRAC to all the electrical components.
The ETRAC releases all the locks and the PDU brake.
Electrical power is transformed into mechanical power by the PDU.
The PDU is composed of:
- a motor and a resolver assembly,
- a brake assembly.

The disc brake of the PDU needs to be energized for release.

When the brake solenoid is de-energized, the disc brake engages:
- to maintain preload of actuation system in fully stowed position,
- to lock the T/R in fully deployed position.

The electrical motor of the PDU gives torque and rotational speed to the flexible shafts,
-Mechanical power is then distributed to middle ball-screw actuators by 2 flexible shafts.
-Mechanical power is distributed to the other 4 actuators by flexible shafts.

Middle actuators have a Manual Drive Unit (MDU) for manual deployment / stowage during maintenance operations.

There are two primary locks, one on the top right actuator and one on the top left actuator.

These internal locks are part of retention means of the thrust reverser system. The function is to lock the thrust reverser when stowed.

Two resolver sensors mounted on the lower actuators monitor the position of the translating cowls.

The EEC detects that:
- upper translating actuators (LHS and RHS) are locked, through the two primary lock system proximity sensors.
- translating cowls are in the stowed position through the lower actuator position cowl resolvers.

The ETRAC implements the ETRAS control functions except for tertiary lock.

The ETRAC commands the left PLS to unlock for deployment, and through the TRPU:
-the right Primary Locking System (PLS) and the PDU disc brake to unlock for deployment,
-the disc brake to engage at the end of the deploy sequence, to secure the T/R in fully deployed position,
-the disc brake to unlock for stowing,
-the electrical motor of the PDU for deployment or stowing,
- to provide monitoring data to the EEC, including ETRAS BITE results, and data of the TRPU internal power switch.

The Tertiary Locking System (TLS) is installed on the nacelle structure at the rear bottom of the left translating cowl.

The function of the TLS is to lock the thrust reverser when it is stowed, in order to prevent an inadvertent deployment, mainly in flight.

The TLS design follows a fail-safe motion in which the TLS engages into a locked position when the electrical power is removed.

The TLS is mechanically locked.

The TLS must be electrically released to deploy.

Two proximity sensors are mounted on this TLS.

The EEC detects that the TLS is locked or unlocked through the two TLS proximity sensors.

First Defense Line

When The EEC detects that the aircraft is on the ground (Landing Gear Extension and Retraction System (LGERS) discrete signal) and Throttle Reverser Angle (TRA) thresholds are reached (-9 degrees for deploy signal and -8 degrees for stow signal), the EEC sends to the ETRAC deploy/stow order for thrust reverser operation.

Second Defense Line

Actuating as the second line of defense of the ETRAS:
- the EIPM will control the switching of low power supply (28 VDC) to the ETRAC for basic control of the thrust reverser system in normal operation and during maintenance operation when the aircraft is on the ground (LGERS discrete signal).
- the EIPM controls and monitors the switching of the 115 VAC 3 phases power supply to the TRPU.

Third Defense Line

The PRIMary flight control and guidance computer (PRIM) installed in the avionics bay will control the switching of the Solid State Power Controller (SSPC) giving the third line of defense of the ETRAS system.

The 115 VAC power supply for the TLS will be transformed and rectified into DC voltage through a TLS Power Unit.

The thrust reverser tertiary lock is the third line of defense to avoid an inadvertent deployment in flight. It stops the mobile structure in case of failure of the primary locks.
The tertiary lock is composed of one electro-mechanical lock, installed on the left 6 o'clock beam.
The tertiary lock can be manually deactivated in the unlock position to manually deploy the sleeves and to get access to the cascades.
Two proximity sensors send the TLS position to the EEC.

Thrust Reverser Operation

Deploy Sequence

The two translating cowls are initially stowed.
The EEC detects that:
- the upper translating actuators (LHS and RHS) are locked through the proximity sensor signals of the PLS.
- the translating cowls are in the stowed position through the translating cowl resolver signals.

The deploy command is set.
The third defense line closes alternative current switch and energizes the TLS once the TRA is detected below the 4.5 degrees position.
The EIPM will command the 115 VAC (3 phases) power supply at the TRPU input once the TRA is detected below the - 7 degrees.
The EEC confirms that the TLS is released through the TLS sensor A & B signals.
The deploy command will be sent by the EEC to the ETRAC through ARINC 429 bus.
The EEC will apply an hysteresis of 0.9 degrees on the throttle position: the throttle deploy condition will be true when the selected TRA is below - 9.0 degrees and will remain true until the selected TRA goes above - 8.1 degrees.
The engine throttle lever moves to a position below - 9.0 degrees.
The TRPU is supplying the electrical power to all the electrical components through ETRAC, which commands locks and the brake to be released. The PDU transforms the electrical power into mechanical power.
The mechanical power is supplied to:
- the two middle ballscrew actuators by two synchro flex shafts.
- the upper and lower actuators by four other flex shafts and the translating cowl moves to the deploy position.

The EEC detects that:
- the PLS are unlocked through the PLS unlock proximity sensor signals.
- the translating cowls are no longer in the stowed position through the left and right translating cowl resolvers signals.

The time for both translating cowls to deploy is monitored.
When both translating cowls reach 80 % of the full stroke, the EEC detects that the thrust reverser is fully deployed through the left and right translating cowl resolvers signals.
Near full deploy position; the speed is reduced to slow.
When 100 % of the stroke is reached, the end actuator hard stop is engaged.
The motors stall at low speed and force limit. The ETRAC de-energizes lock drivers, brake drivers and disables inverter.
The aircraft opens alternative current switch and de-energizes the TLS.

Stow Sequence

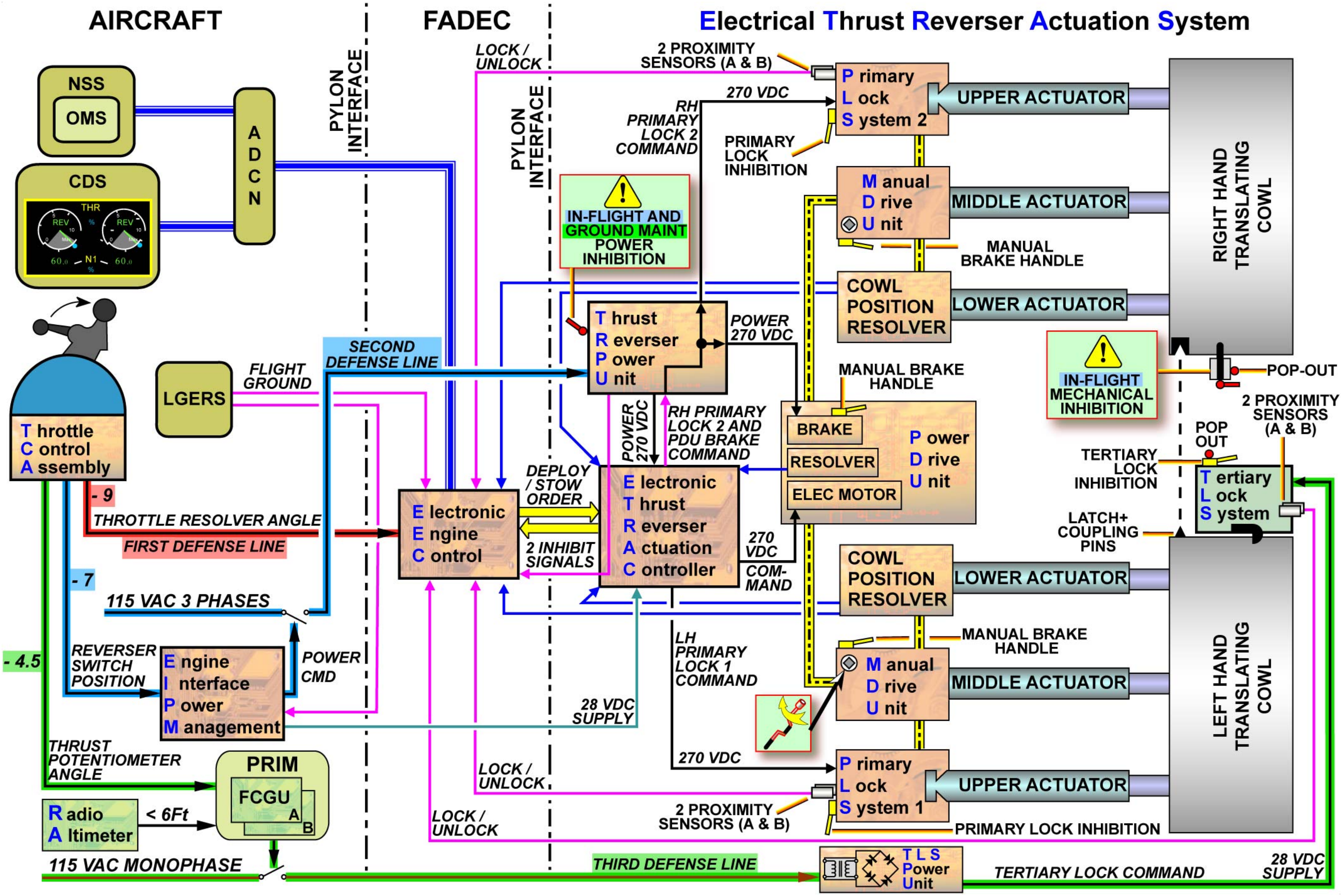
When the Aircraft is on the ground and a deploy command has previously been executed, or partially executed, the pilot selecting forward thrust will cause the EEC to initiate a stow command. The EEC will send the stow command to the ETRAC via the data bus which will then release the brake and command the motor to rotate in the opposite direction drawing the sleeves to close. The stow command will be transmitted continuously by the EEC to the ETRAC until the EEC detects the thrust reverser to be fully stowed.
The STOW sequence follows different steps:
The system is initially in the deployed position.

The engine throttle lever moves to the forward position and above - 8 degrees.
The EEC detects the TRA position above - 8 degrees.
The stow command sent by the EEC to the ETRAC through ARINC 429 bus.
The aircraft closes alternative current switches and energizes the TLS once the TRA is detected up to - 4.5 degrees position.
The TRPU supplies the electrical power to all electrical components through the ETRAC, which commands the locks and brake to be released. The electrical power is transformed into mechanical power by the PDU.
The mechanical power is supplied to:
- the two middle ballscrew actuators by the two synchro flex shafts.
- the upper and lower actuators by four other flex shafts and let the translating cowl moves to the stowed position.

The EEC detects that:
- the PLS are unlocked through the PLS unlock proximity sensor signals.
- the translating cowls are no longer in the deployed position through the left and right translating cowl resolver signals.

The translating cowls reach the position at which the tertiary lock is mechanically locked.
The EEC detects that:
- the TLS is locked through the TLS sensor signals.
- the PLS are locked through the PLS unlock proximity sensor signals.
- the translating cowls are in the stow position through the left and right translating cowl resolvers signal.
- the thrust reverser is stowed and locked.

The EIPM switches off the 115 VAC (3 phase) power supply at the TRPU input at the end of the stow sequence when the EEC indicates that the thrust reversers are locked with a confirmation of 1 second.
The ETRAC 28 VDC will be isolated by the EIPM.


AIRCRAFT
FADEC
Electrical Thrust Reverser Actuation System
PYLON INTERFACE
PYLON INTERFACE
NSS
OMS
CDS
THR
REV
N1
ADCN
LOCK / UNLOCK
2 PROXIMITY SENSORS (A & B)
270 VDC
RH PRIMARY LOCK 2 COMMAND
PRIMARY LOCK INHIBITION
Primary Lock System 2
UPPER ACTUATOR
Manual Drive Unit
MIDDLE ACTUATOR
MANUAL BRAKE HANDLE
COWL POSITION RESOLVER
LOWER ACTUATOR
RIGHT HAND TRANSLATING COWL
IN-FLIGHT AND GROUND MAINT POWER INHIBITION
Thrust Reverser Power Unit
POWER 270 VDC
SECOND DEFENSE LINE
FLIGHT GROUND
LGERS
Throttle Control Assembly
MANUAL BRAKE HANDLE
BRAKE
RESOLVER
ELEC MOTOR
Power Drive Unit
IN-FLIGHT MECHANICAL INHIBITION
POP-OUT
2 PROXIMITY SENSORS (A & B)
POP OUT
TERTIARY LOCK INHIBITION
Tertiary Lock System
LATCH+ COUPLING PINS
POWER 270 VDC
RH PRIMARY LOCK 2 AND PDU BRAKE COMMAND
DEPLOY / STOW ORDER
Electronic Engine Control
Electronic Thrust Reverser Actuation Controller
2 INHIBIT SIGNALS
270 VDC
COM-MAND
- 9
THROTTLE RESOLVER ANGLE
FIRST DEFENSE LINE
- 7
115 VAC 3 PHASES
COWL POSITION RESOLVER
LOWER ACTUATOR
LEFT HAND TRANSLATING COWL
- 4.5
REVERSER SWITCH POSITION
Engine Interface Power Management
POWER CMD
28 VDC SUPPLY
LH PRIMARY LOCK 1 COMMAND
MANUAL BRAKE HANDLE
Manual Drive Unit
MIDDLE ACTUATOR
THRUST POTENTIOMETER ANGLE
PRIM
FCGU
A
B
LOCK / UNLOCK
270 VDC
Primary Lock System 1
UPPER ACTUATOR
2 PROXIMITY SENSORS (A & B)
Radio Altimeter
< 6Ft
LOCK / UNLOCK
PRIMARY LOCK INHIBITION
115 VAC MONOPHASE
THIRD DEFENSE LINE
TLS Power Unit
TERTIARY LOCK COMMAND
28 VDC SUPPLY

GENERAL ... THRUST REVERSER OPERATION

LB408521 - L5CT0T0 - LM7EDJ000000001

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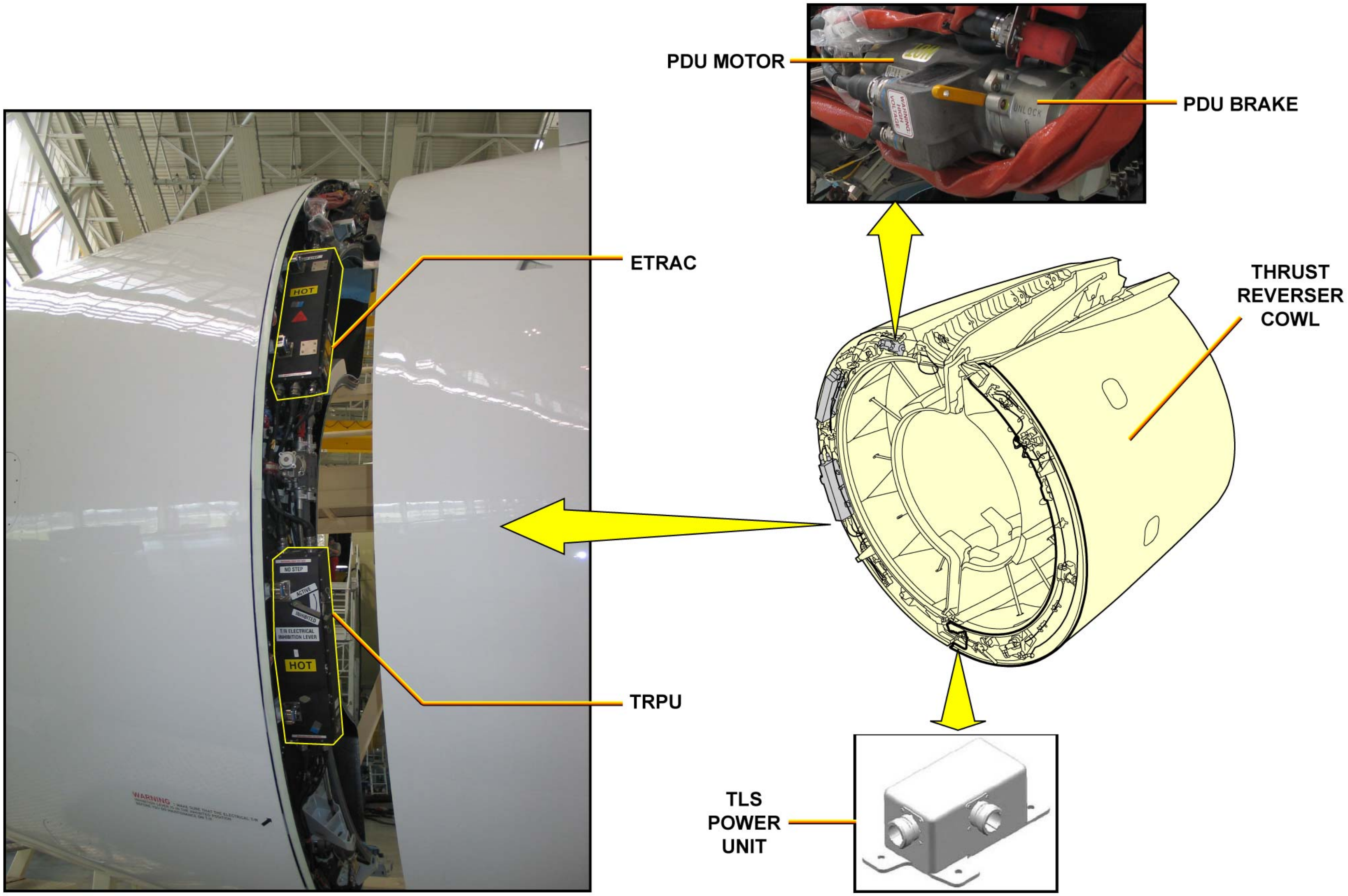
THRUST REVERSER CONTROL DESCRIPTION (3)

Major Component Identification

The major components of the ETRAS are installed on the forward frame of the Right Hand (RH) Thrust Reverser cowl:
- The PDU is installed on the upper part,
- The ETRAC and TRPU are installed on the middle side,
- The TLS Power Unit is installed on the lower part.


PDU MOTOR
PDU BRAKE
ETRAC
THRUST REVERSER COWL
TRPU
TLS POWER UNIT

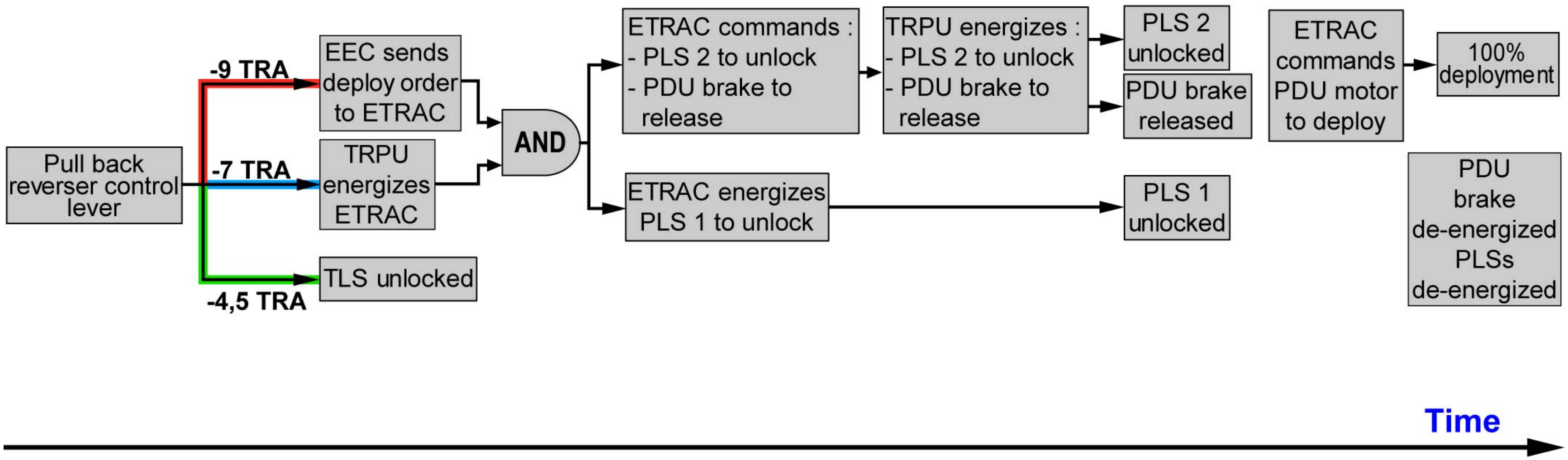
MAJOR COMPONENT IDENTIFICATION

THRUST REVERSER CONTROL DESCRIPTION (3)

Summary

The following schematic summarizes the deploy and stow sequence.

Deploy Sequence


Pull back reverser control lever

-9 TRA

-7 TRA

-4,5 TRA

EEC sends deploy order to ETRAC

TRPU energizes ETRAC

TLS unlocked

AND

ETRAC commands :
- PLS 2 to unlock
- PDU brake to release

ETRAC energizes PLS 1 to unlock

TRPU energizes :
- PLS 2 to unlock
- PDU brake to release

PLS 2 unlocked

PDU brake released

PLS 1 unlocked

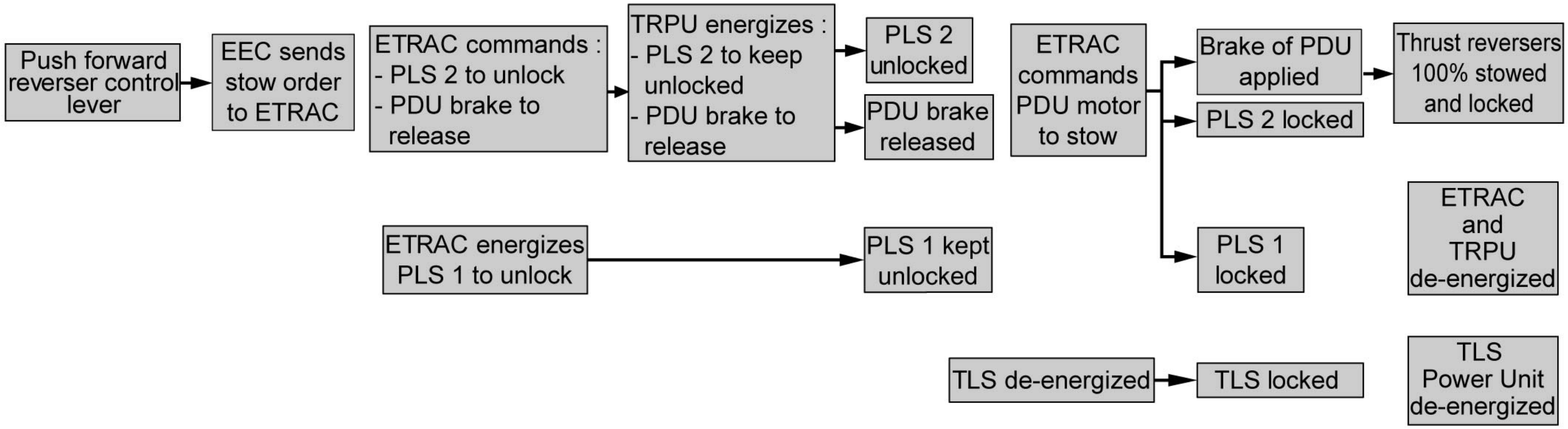
ETRAC commands PDU motor to deploy

100% deployment

PDU brake de-energized PLSs de-energized

Time

Stow Sequence


Push forward reverser control lever

EEC sends stow order to ETRAC

ETRAC commands :
- PLS 2 to unlock
- PDU brake to release

ETRAC energizes PLS 1 to unlock

TRPU energizes :
- PLS 2 to keep unlocked
- PDU brake to release

PLS 2 unlocked

PDU brake released

PLS 1 kept unlocked

ETRAC commands PDU motor to stow

Brake of PDU applied

PLS 2 locked

PLS 1 locked

Thrust reversers 100% stowed and locked

ETRAC and TRPU de-energized

TLS de-energized

TLS locked

TLS Power Unit de-energized

SUMMARY

THRUST REVERSER INHIBITION (2)

FADEC

General Architecture

The Full Authority Digital Engine Control (FADEC) system receives signals from the various aircraft sub-systems and the engine sensors. These signals let the FADEC provide all the necessary features to control the engine, the command stow and deploy of the thrust reverser and to provide engine data to the aircraft.
The system is composed of:
- Electronic Engine Control (EEC),
- Vibration Monitoring Unit (VMU).

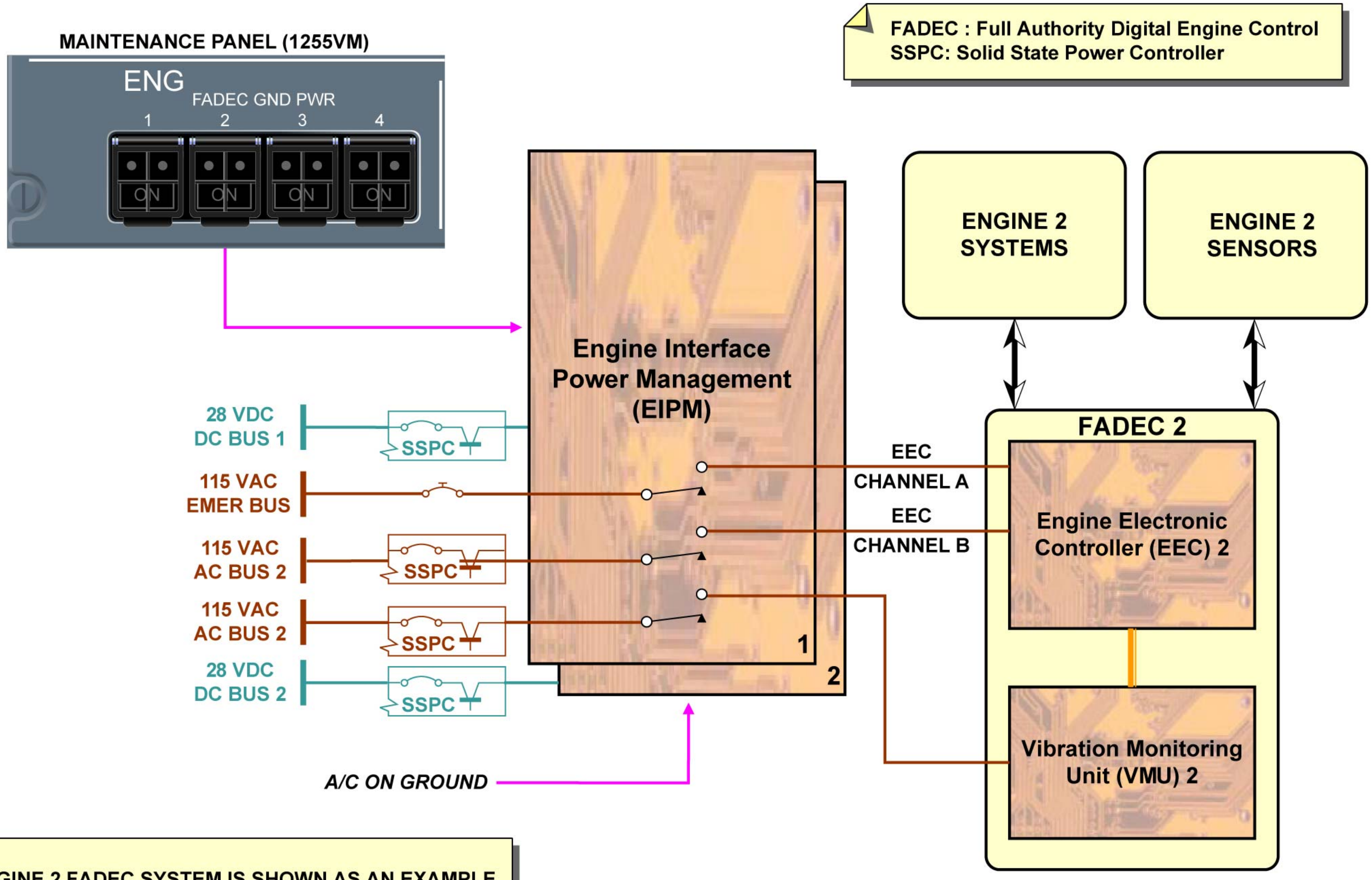
The EEC is the FADEC central unit, which is a full authority, dual channel, and the digital electronic control unit interfacing with the aircraft and engine control system components.
The VMU monitors engine vibration.
For maintenance functions, the FADEC system can be energized from the ENGine FADEC GrouND PoWeR P/BSW located on the overhead maintenance panel. The Engine Interface Power Management (EIPM) computer achieves the power supply command.

Supply on Ground

The power supply of the FADEC systems is controlled by the EIPM computer, which supplies the electrical power from the aircraft to the FADEC systems. When the engine is not running, the EEC gets its 115 VAC power supply from the AC BUS 2 and the AC EMER BUS. The VMU is supplied in 115 VAC from the AC BUS 2. The EIPM computer 1(2) itself is supplied in 28 VDC from the DC BUS 1(2).
During on-ground maintenance operations, setting the FADEC GND PWR P/BSW to ON lets the EEC and the VMU be energized for 10 minutes.
The EEC and the VMU will stay permanently energized if the EEC INTERACTIVE mode is set through the Central Maintenance System (CMS).

Releasing out the FADEC GND PWR P/BSW cuts the EEC power supply.

FADEC : Full Authority Digital Engine Control
SSPC: Solid State Power Controller


MAINTENANCE PANEL (1255VM)
ENG
FADEC GND PWR
1
2
3
4
ON
ON
ON
ON
Engine Interface Power Management (EIPM)
1
2
ENGINE 2 SYSTEMS
ENGINE 2 SENSORS
FADEC 2
Engine Electronic Controller (EEC) 2
Vibration Monitoring Unit (VMU) 2
EEC CHANNEL A
EEC CHANNEL B
28 VDC DC BUS 1
115 VAC EMER BUS
115 VAC AC BUS 2
115 VAC AC BUS 2
28 VDC DC BUS 2
SSPC
SSPC
SSPC
SSPC
A/C ON GROUND

ENGINE 2 FADEC SYSTEM IS SHOWN AS AN EXAMPLE

FADEC - GENERAL ARCHITECTURE & SUPPLY ON GROUND

LB408521 - L5CT0T0 - LM7EDSLEVEL0201

THRUST REVERSER INHIBITION (2)

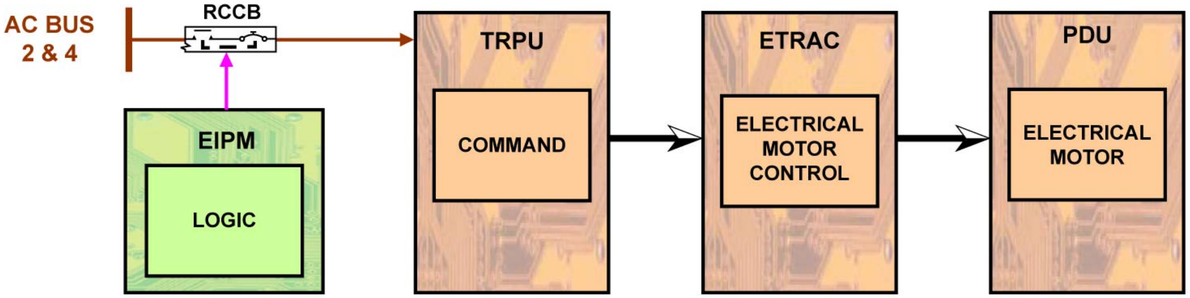
Thrust Reverser

Power Inhibition for Maintenance

To make sure that the thrust reverser system is unserviceable for maintenance, the Thrust Reverser Power Unit (TRPU) has to be deactivated by inhibiting the power supply of the thrust reverser system. The TRPUs are installed on the inboard engines only, under the RH fan cowl door.

In normal operation, the TRPU is powered with 115 VAC 3 phase by the EIPM logic. The TRPU then energizes the Electronic Thrust Reverser Actuation Controller (ETRAC), which will supply the Power Drive Unit (PDU) to control the actuators.

So the power supply inhibition requires the removal of the ball pin from the TRPU and to turn the TRPU lever to the "INHIBITED" position. The ball pin must be re-installed. When the TRPU lever is in the "INHIBITED" position, the ETRAC is no longer supplied. The pin of the reverse inhibition kit with the "REMOVE BEFORE FLIGHT" flag must be installed in the TRPU hole.



AC BUS 2 & 4

RCCB

EIPM

LOGIC

TRPU

COMMAND

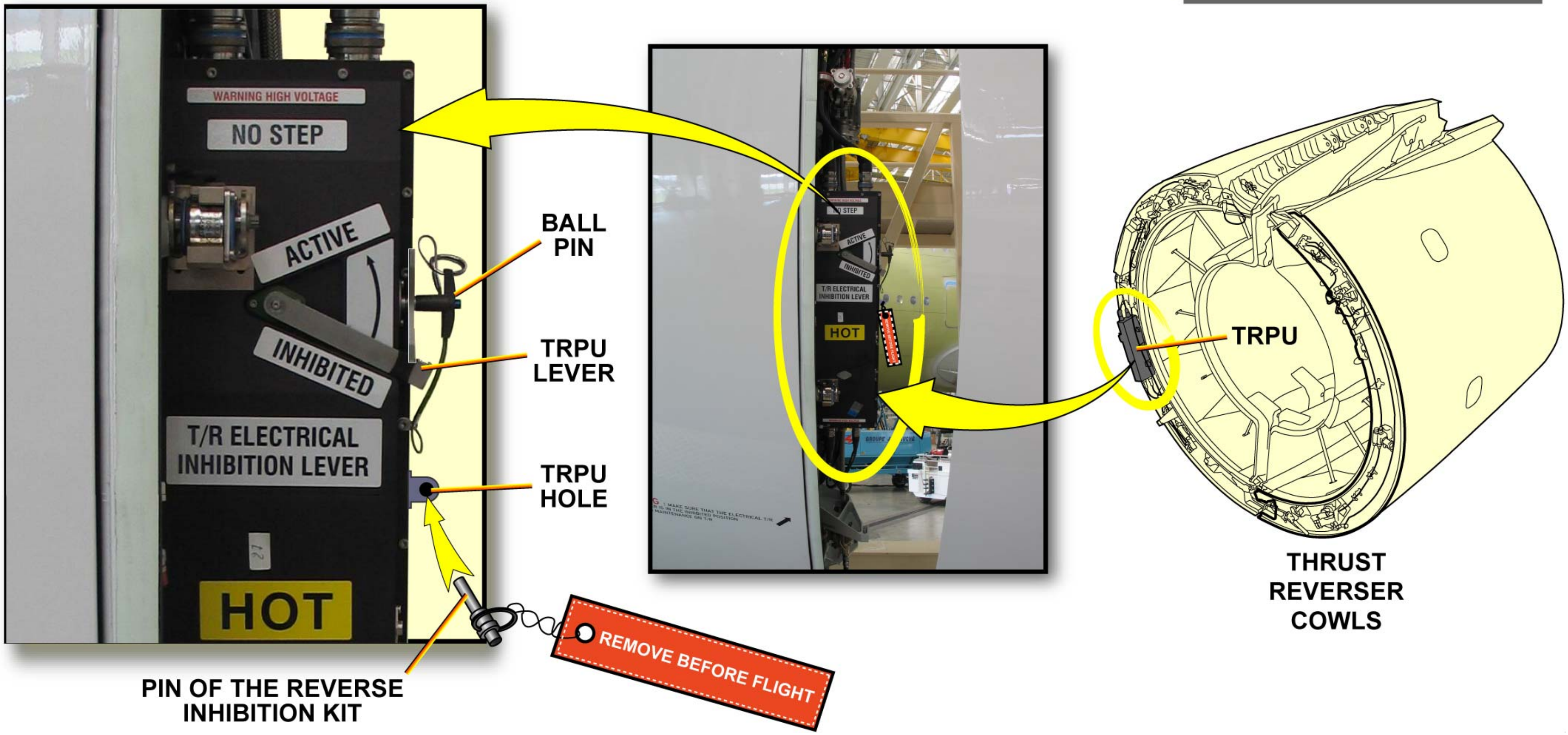
ETRAC

ELECTRICAL MOTOR CONTROL

PDU

ELECTRICAL MOTOR

TRPU:	Thrust Reverser Power Unit
EIPM:	Engine Interface Power Management
ETRAC:	Electrical Thrust Reverser Actuation Controller
PDU:	Power Drive Unit
RCCB:	Remote Control Circuit Breaker


WARNING HIGH VOLTAGE
NO STEP
ACTIVE
INHIBITED
T/R ELECTRICAL INHIBITION LEVER
HOT
BALL PIN
TRPU LEVER
TRPU HOLE
PIN OF THE REVERSE INHIBITION KIT
REMOVE BEFORE FLIGHT
TRPU
THRUST REVERSER COWLS

THRUST REVERSER - POWER INHIBITION FOR MAINTENANCE

LB408521 - L5CT0T0 - LM7EDSLEVEL0201

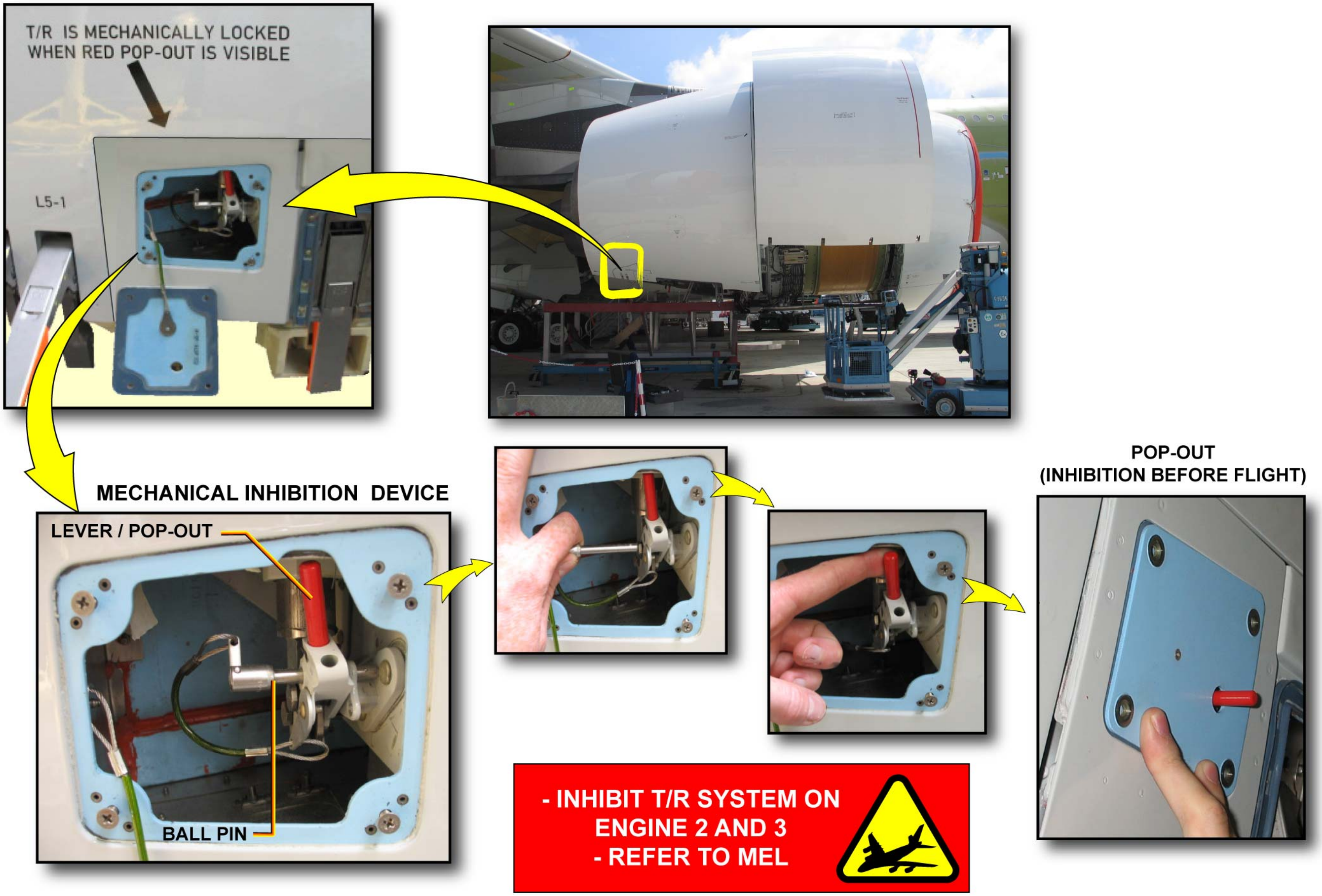
THRUST REVERSER INHIBITION (2)

Thrust Reverser (continued)

Power Inhibition and Mechanical Inhibition Before Flight

To make sure that the thrust reverser system is unserviceable for flight, the TRPU has to be electrically deactivated and the two translating cowls mechanically deactivated. The mechanical inhibition device of the thrust reverser is accessed by loosening the four captive screws on the mechanical inhibition access panel installed on the rear lower part of the thrust reverser cowls.
The mechanical inhibition requires the removal of the ball pin from the mechanical device. The mechanical device is then pushed to the "INHIBITED" position. The ball pin has to be re-installed to lock the mechanical device. When the thrust reverser system is mechanically inhibited a red pop-out is visible on the inhibition access panel.
Human factor points:

WARNING: - TO INHIBIT THE THRUST REVERSER SYSTEM YOU MUST INHIBIT IT ON ENGINE 2 AND 3,
- REFER TO MMEL.


T/R IS MECHANICALLY LOCKED
WHEN RED POP-OUT IS VISIBLE
L5-1
MECHANICAL INHIBITION DEVICE
LEVER / POP-OUT
BALL PIN
POP-OUT
(INHIBITION BEFORE FLIGHT)

- INHIBIT T/R SYSTEM ON ENGINE 2 AND 3
- REFER TO MEL

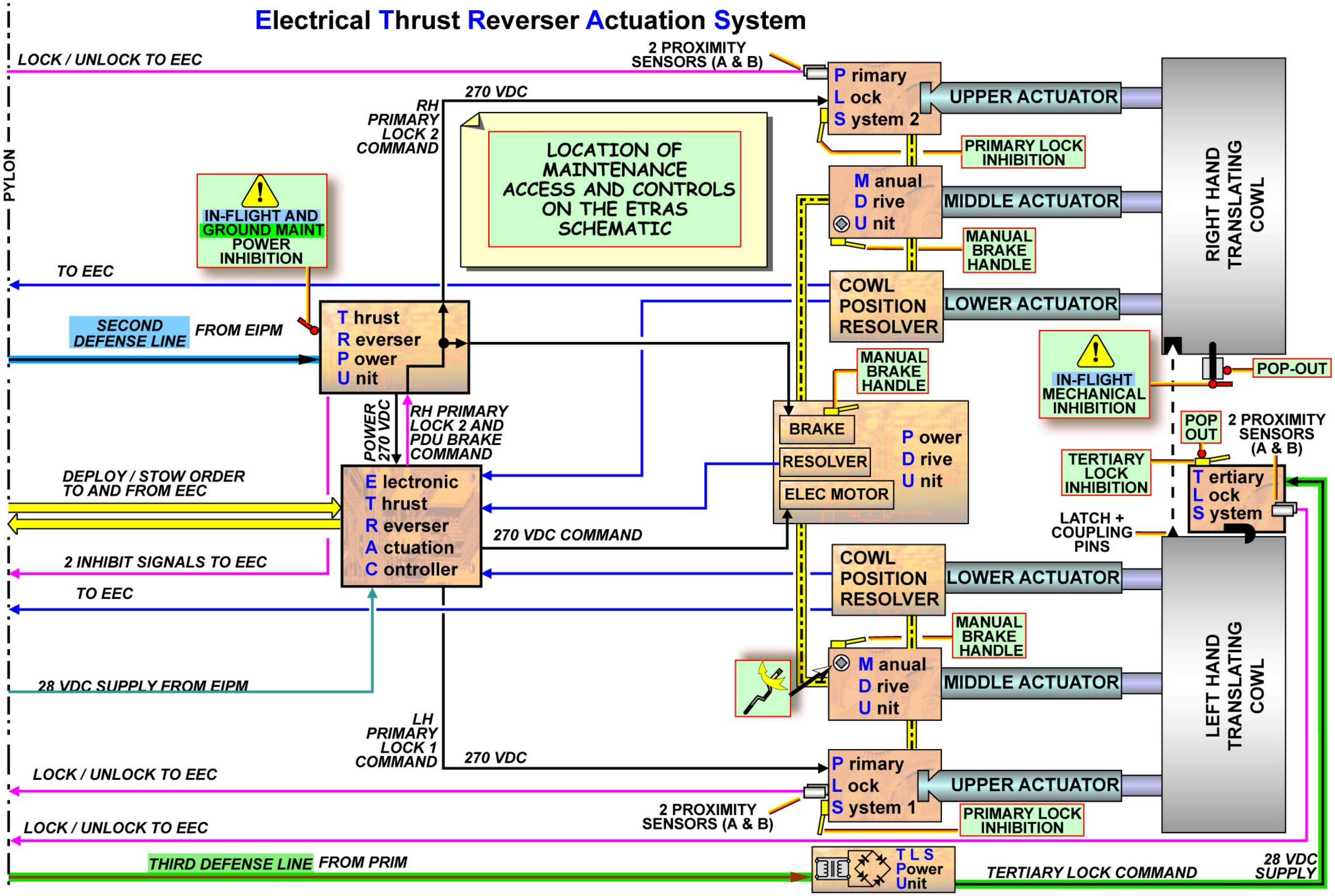
THRUST REVERSER - POWER INHIBITION AND MECHANICAL INHIBITION BEFORE FLIGHT

THRUST REVERSER MAINTENANCE (3)

Manual Deploy/Stow the Thrust Reverser Translating Cowl

The procedure to manually deploy the thrust reverser translating cowl is:
- Make the thrust reverser unserviceable for maintenance (Thrust Reverser Power Unit (TRPU) inhibition),
- Make the Tertiary Lock System (TLS) of the thrust reverser unserviceable,
- Unlock the Primary Lock System (PLS) of the left thrust reverser,
- Release the brake of the Power Drive Unit (PDU),
- Unlock the PLS of right thrust reverser,
- Make the right and left Manual Drive Units (MDUs) of the thrust reverser operative,
- Manually deploy the thrust reverser translating cowl,
- Make the right and left MDUs of the thrust reverser inoperative.

The procedure to manually stow the thrust reverser translating cowl is:
- Make the thrust reverser unserviceable for maintenance,
- Make the TLS of the thrust reverser unserviceable,
- Make the right and left MDU of the thrust reverser operative,
- Activate the PLS of the right thrust reverser,
- Activate the PLS of the left thrust reverser,
- Manually stow the thrust reverser translating cowl,
- Make the right and left MDU of the thrust reverser inoperative,
- Activate the brake of the PDU.


Electrical Thrust Reverser Actuation System
PYLON
LOCK / UNLOCK TO EEC
2 PROXIMITY SENSORS (A & B)
Primary Lock System 2
UPPER ACTUATOR
270 VDC
RH PRIMARY LOCK 2 COMMAND
LOCATION OF MAINTENANCE ACCESS AND CONTROLS ON THE ETRAS SCHEMATIC
PRIMARY LOCK INHIBITION
Manual Drive Unit
MIDDLE ACTUATOR
RIGHT HAND TRANSLATING COWL
IN-FLIGHT AND GROUND MAINT POWER INHIBITION
MANUAL BRAKE HANDLE
TO EEC
COWL POSITION RESOLVER
LOWER ACTUATOR
SECOND DEFENSE LINE
FROM EIPM
Thrust Reverser Power Unit
MANUAL BRAKE HANDLE
IN-FLIGHT MECHANICAL INHIBITION
POP-OUT
POWER 270 VDC
RH PRIMARY LOCK 2 AND PDU BRAKE COMMAND
BRAKE
RESOLVER
ELEC MOTOR
Power Drive Unit
POP OUT
2 PROXIMITY SENSORS (A & B)
TERTIARY LOCK INHIBITION
Tertiary Lock System
DEPLOY / STOW ORDER TO AND FROM EEC
Electronic Thrust Reverser Actuation Controller
LATCH + COUPLING PINS
270 VDC COMMAND
2 INHIBIT SIGNALS TO EEC
COWL POSITION RESOLVER
LOWER ACTUATOR
TO EEC
MANUAL BRAKE HANDLE
Manual Drive Unit
MIDDLE ACTUATOR
LEFT HAND TRANSLATING COWL
28 VDC SUPPLY FROM EIPM
LH PRIMARY LOCK 1 COMMAND
270 VDC
Primary Lock System 1
UPPER ACTUATOR
LOCK / UNLOCK TO EEC
2 PROXIMITY SENSORS (A & B)
PRIMARY LOCK INHIBITION
LOCK / UNLOCK TO EEC
THIRD DEFENSE LINE
FROM PRIM
TLS Power Unit
TERTIARY LOCK COMMAND
28 VDC SUPPLY

MANUAL DEPLOY/STOW THE THRUST REVERSER TRANSLATING COWL

LB408521 - L5CT0T0 - LM7EY4000000001

THRUST REVERSER MAINTENANCE (3)

Manual Deploy/Stow the Thrust Reverser Translating Cowl (continued)

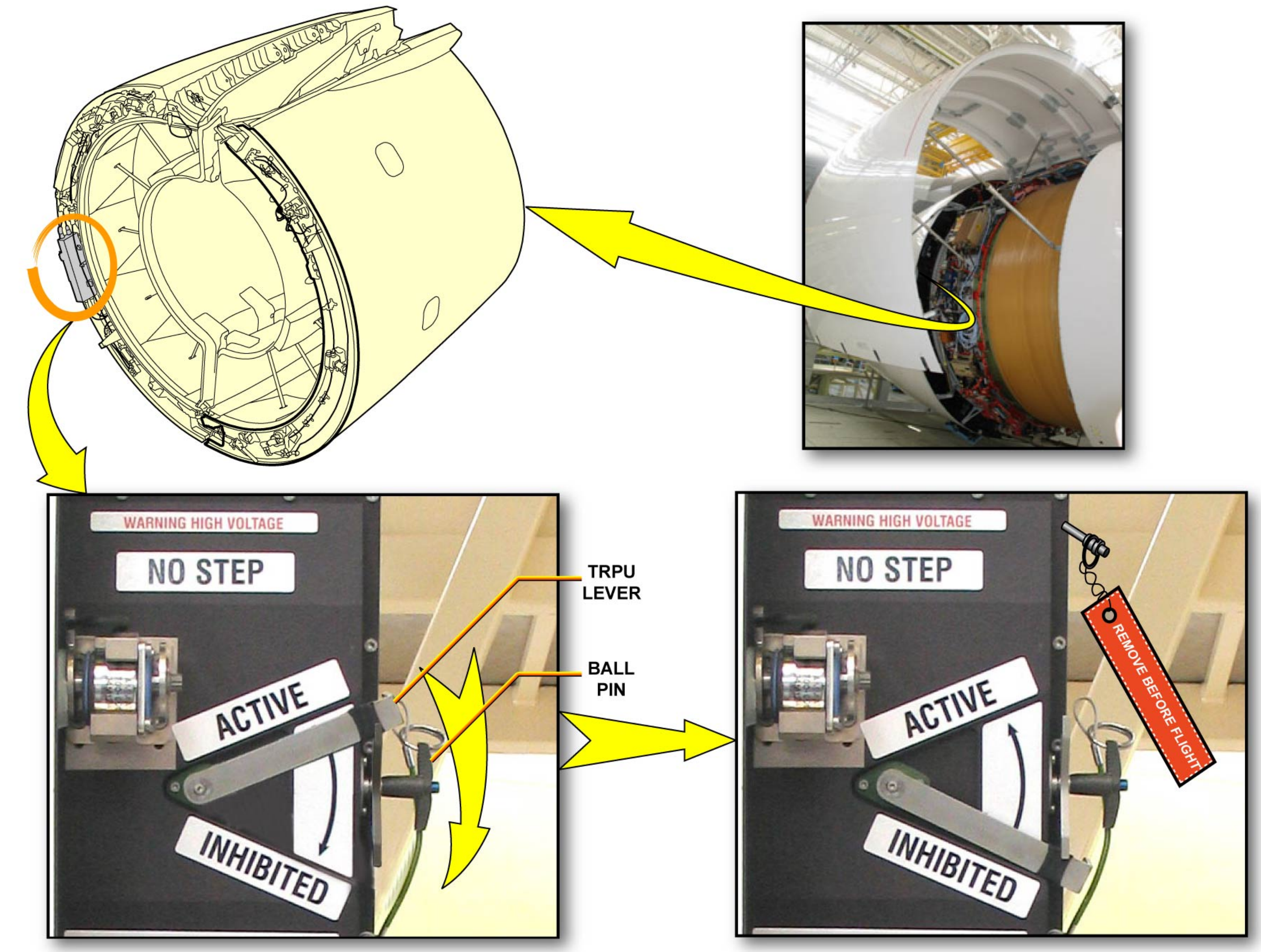
Make the Thrust Reverser Unserviceable for Maintenance

WARNING: YOU MUST MAKE THE THRUST REVERSER UNSERVICEABLE (INSTALLATION AND SECURIZATION OF THE INHIBITION DEVICE) BEFORE YOU DO A WORK ON OR AROUND THE THRUST REVERSER. IF YOU DO NOT INSTALL AND SECURE THE INHIBITION DEVICE, YOU CAN CAUSE ACCIDENTAL OPERATION OF THE THRUST REVERSER AND INJURY TO PERSONS AND/OR DAMAGE TO THE EQUIPMENT.

The opening of fan cowl doors gives access to the TRPU.
To make the TRPU unserviceable, you must:
- Remove the ball pin from the TRPU,
- Move the TRPU lever to the "INHIBITED" position,
- Install the ball pin on the TRPU,

CAUTION: AFTER INSTALLATION OF THE BALL PIN, CHECK THAT THE BALL PIN IS CORRECTLY INSTALLED BY PULLING IT.

- Install the lock out pin with the "Remove Before Flight" flag in the TRPU hole.


WARNING HIGH VOLTAGE
NO STEP
ACTIVE
INHIBITED
TRPU LEVER
BALL PIN
WARNING HIGH VOLTAGE
NO STEP
ACTIVE
INHIBITED
REMOVE BEFORE FLIGHT

TRPU ON "ACTIVE" POSITION

TRPU ON "INHIBITED" POSITION

MANUAL DEPLOY/STOW THE THRUST REVERSER TRANSLATING COWL - MAKE THE THRUST REVERSER UNSERVICEABLE FOR MAINTENANCE

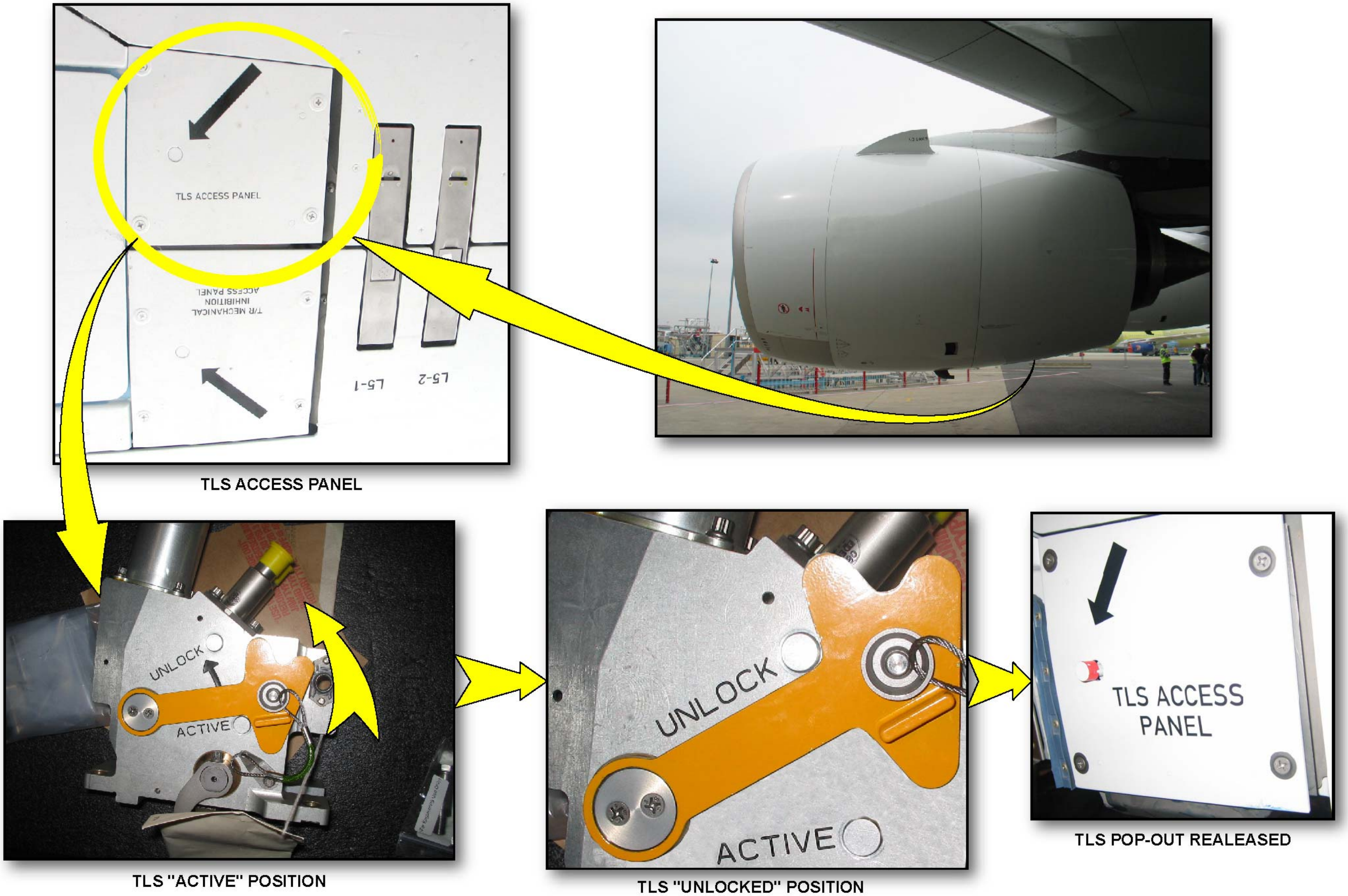
THRUST REVERSER MAINTENANCE (3)

Manual Deploy/Stow the Thrust Reverser Translating Cowl (continued)

Make the TLS of the Thrust Reverser Unserviceable

Thrust reverser TLS is located at the lower part of the thrust reverser behind the mechanical inhibition access door
To make the thrust reverser TLS unserviceable, you must:
- Remove the ball pin from the TLS,
- Move the yellow lever to the "UNLOCKED" position,
- Install the ball pin to lock the lever.

NOTE: When the access door is closed, make sure that the visual pop-out is visible.


TLS ACCESS PANEL
T/R MECHANICAL INHIBITION ACCESS PANEL
L5-1
L5-2
UNLOCK
ACTIVE
UNLOCK
ACTIVE
TLS ACCESS PANEL

TLS ACCESS PANEL

TLS "ACTIVE" POSITION

TLS "UNLOCKED" POSITION

TLS POP-OUT REALEASED

MANUAL DEPLOY/STOW THE THRUST REVERSER TRANSLATING COWL - MAKE THE TLS OF THE THRUST REVERSER UNSERVICEABLE

THRUST REVERSER MAINTENANCE (3)

Manual Deploy/Stow the Thrust Reverser Translating Cowl (continued)

Unlock/Active the PLS of the Thrust Reverser

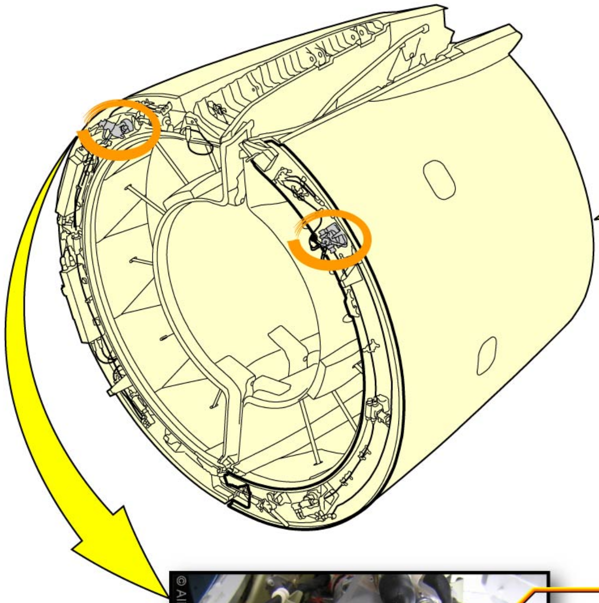
There are two PLS per engine. The opening of fan cowl doors gives access to PLS.

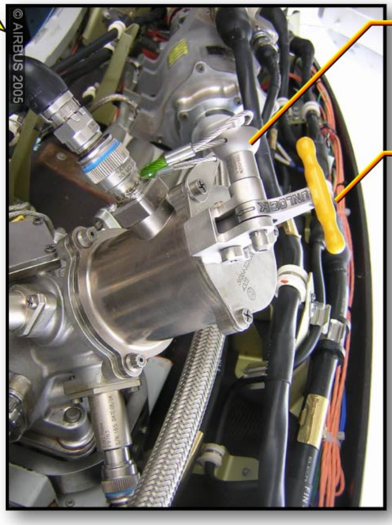
To unlock the PLS of the thrust reverser, you must:

- Remove the inhibition pin from the end of the lever,
- Rotate the lever to put the translating axis knob in the "UNLOCKED" position,
- Install the inhibition pin at the end of the lever.

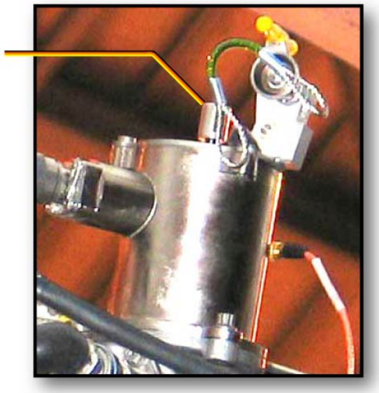
To activate the PLS of the thrust reverser, you must:

- Remove the inhibition pin from the end of the lever,
- Rotate the lever to put the translating axis knob in the "ACTIVE" position,
- Install the inhibition pin at the end of the lever.




© AIRBUS 2005
INHIBITION PIN
PLS LEVER

PLS ON "ACTIVE POSITION"



MANUAL DEPLOY/STOW THE THRUST REVERSER TRANSLATING COWL - UNLOCK/ACTIVE THE PLS OF THE THRUST REVERSER

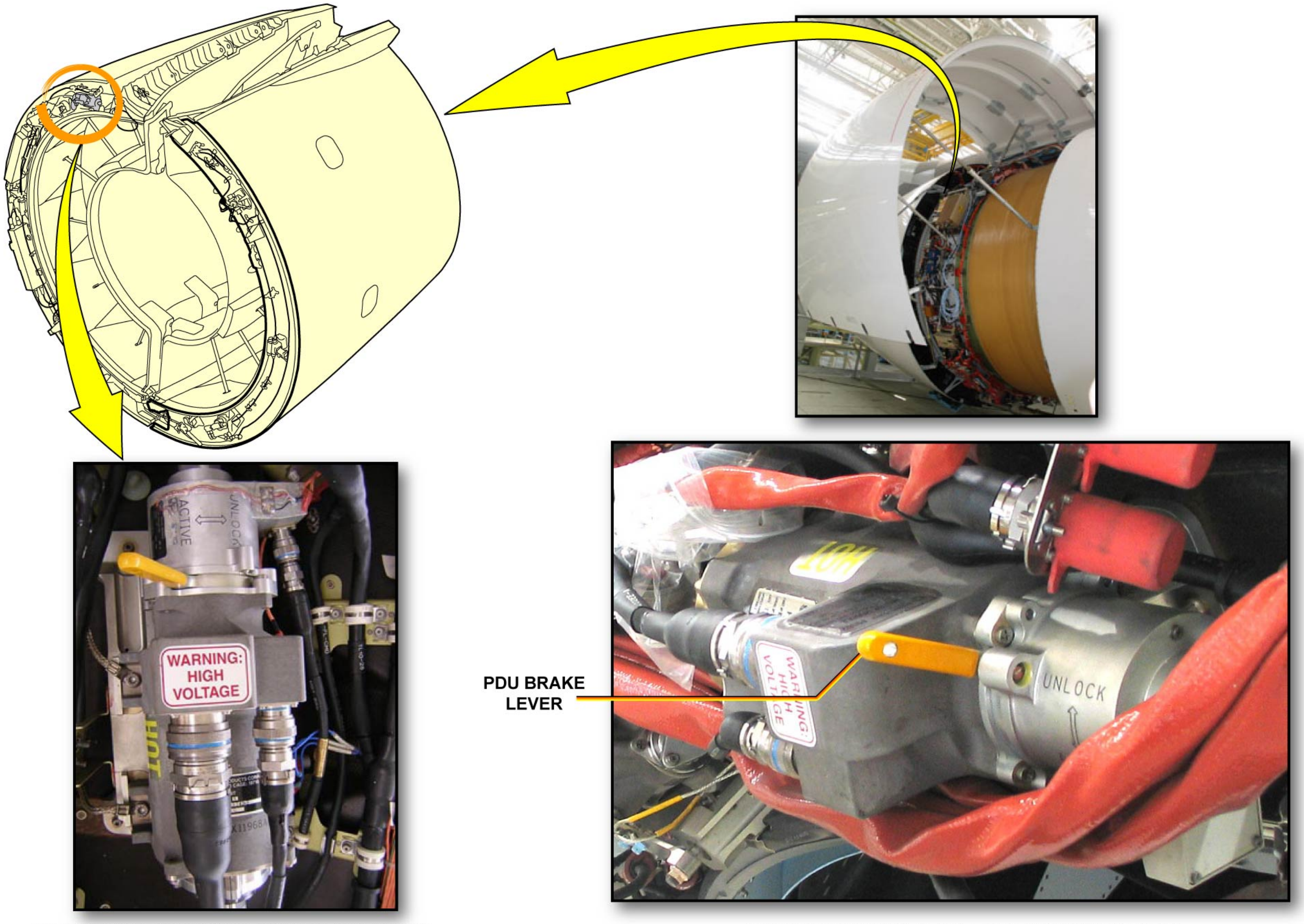
THRUST REVERSER MAINTENANCE (3)

Manual Deploy/Stow the Thrust Reverser Translating Cowl (continued)

Release/Active the Brake of the PDU

The Power Drive Unit (PDU) is installed behind the fan cowl doors.
To release the brake of the PDU, you must:
- Move the yellow lever to the "UNLOCKED" position.

To activate the brake of the PDU, you must:
- Move the yellow lever to the "ACTIVE" position.


ACTIVE
UNLOCK
WARNING:
HIGH
VOLTAGE
HOT
PDU BRAKE
LEVER
UNLOCK

PDU BRAKE LEVER IN THE "ACTIVE" POSITION

PDU BRAKE LEVER IN THE "UNLOCKED" POSITION

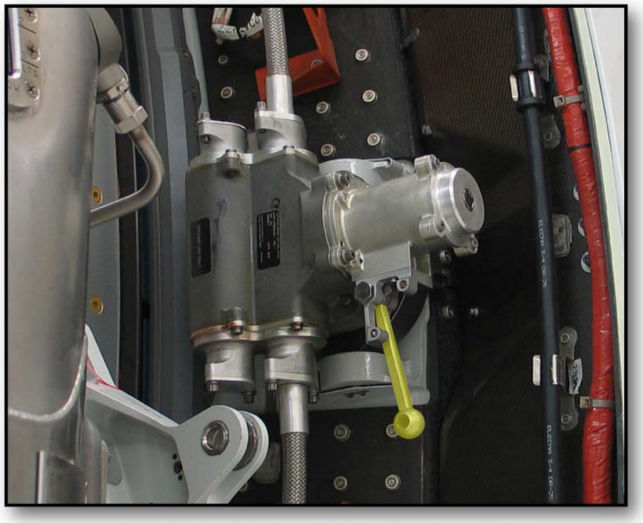
MANUAL DEPLOY/STOW THE THRUST REVERSER TRANSLATING COWL - RELEASE/ACTIVE THE BRAKE OF THE PDU

THRUST REVERSER MAINTENANCE (3)

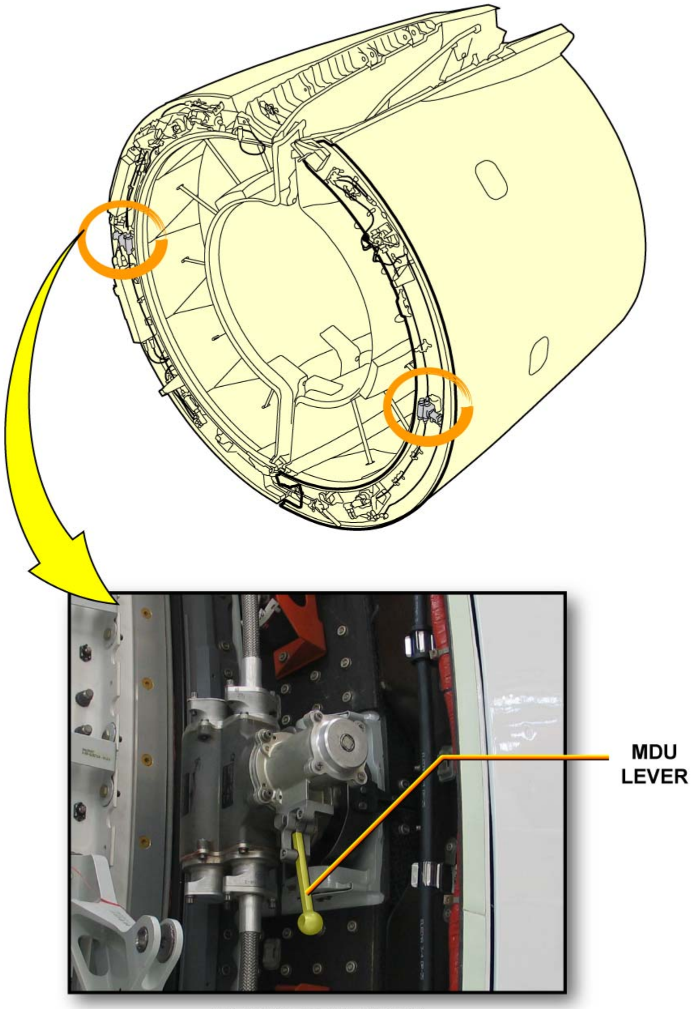
Manual Deploy/Stow the Thrust Reverser Translating Cowl (continued)

Lock/Unlock of the MDUs

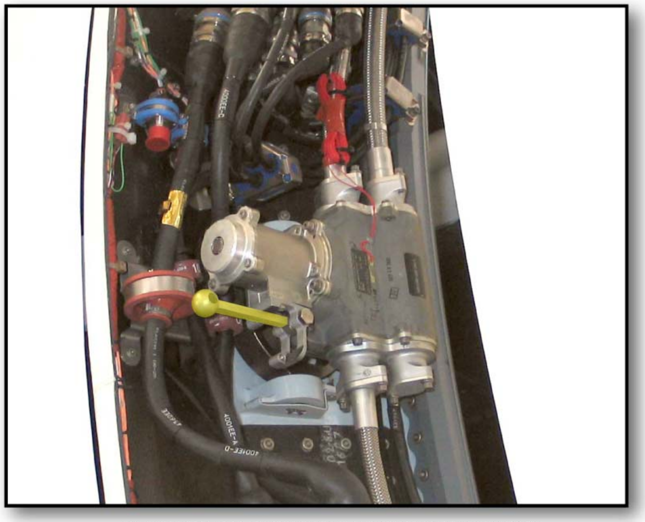
There are two Manual Drive Units (MDUs) per engine. They are installed behind the fan cowl doors.
To unlock the MDUs, you must set the yellow levers of the two MDUs on the "ACTIVE" position.
To lock the MDUs, you must set the yellow levers of the two MDUs on the "LOCKED" position.



MDU LEVER ON THE "ACTIVE" POSITION



MANUAL DRIVE UNIT`



MDU LEVER ON THE "LOCKED" POSITION

MANUAL DEPLOY/STOW THE THRUST REVERSER TRANSLATING COWL - LOCK/UNLOCK OF THE MDUS

THRUST REVERSER MAINTENANCE (3)

Manual Deploy/Stow the Thrust Reverser Translating Cowl (continued)

Manually Deploy/Stow the Thrust Reverser Translating Cowls

To manually deploy the translating cowls of the thrust reverser, you must:
- Put the 3/8 inch speed wrench at the MDU,

NOTE: - Make sure that the male square drive of the speed wrench is correctly engaged in the MDU, before you turn the MDU.
- You can use special pneumatic or electrical tool to turn the MDU.

- Push and turn the MDU clockwise to deploy the translating cowls of the thrust reverser until the MDU torque limiter releases,

NOTE: The translating cowls can be deployed either with the left MDU or with the right MDU.

- Remove the speed wrench.

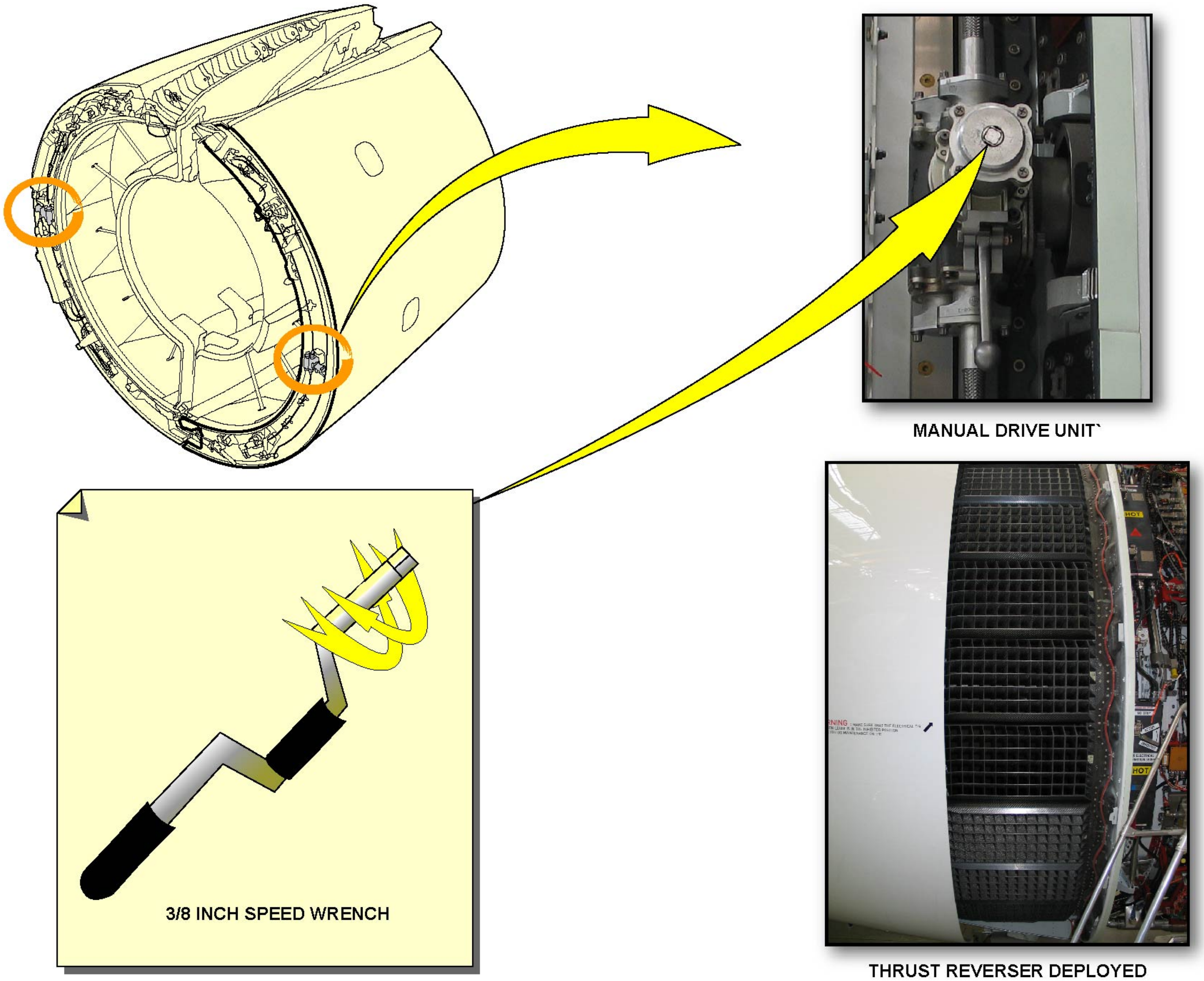
To manually stow the translating cowls of the thrust reverser, you must:
-Put the 3/8 inch speed wrench at the MDU,

NOTE: - Make sure that the male square drive of the speed wrench is correctly engaged in the MDU, before you turn the MDU.
- You can use special pneumatic or electrical tool to turn the MDU.

- Push and turn the MDU counter-clockwise to stow the translating cowls of the thrust reverser until the MDU torque limiter releases,

NOTE: The translating cowls can be stowed either with the left MDU or with the right MDU.

- Remove the speed wrench.


MANUAL DRIVE UNIT`
3/8 INCH SPEED WRENCH
THRUST REVERSER DEPLOYED

MANUAL DEPLOY/STOW THE THRUST REVERSER TRANSLATING COWL - MANUALLY DEPLOY/STOW THE THRUST REVERSER TRANSLATING COWLS

AIRBUS

AIRBUS S.A.S.
31707 BLAGNAC cedex, FRANCE
STM
REFERENCE LB408521
JANUARY 2009
PRINTED IN FRANCE
AIRBUS S.A.S. 2009
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